



ILRI strategy to 2010

making the Livestock Revolution
work for the poor

published 2000

International Livestock Research Institute
PO Box 30709, Nairobi, Kenya

tel: (254 2) 630743

fax: (254 2) 631499

email: ilri@cgiar.org

website: <http://www.cgiar.org/ilri>

correct citation: ILRI (International Livestock Research Institute). 2000. *Livestock Strategy to 2010: Making the Livestock Revolution Work for the Poor*. ILRI, Nairobi, Kenya.

Contents

The vision, mission and mandate of ILRI v

Executive summary vi

Preface ix

Acknowledgements xi

1 External influences shaping ILRI's strategy 1

- 1.1 Role of livestock in poverty reduction, food and nutritional security, the environment and human health 1
 - 1.1.1 Poverty reduction 1
 - 1.1.2 The environment 5
 - 1.1.3 Human health 6
- 1.2 Livestock demand trends 7
- 1.3 Livestock production trends 9
- 1.4 The productivity challenge 10
- 1.5 Evolution of livestock systems 11
 - 1.5.1 Grazing systems 11
 - 1.5.2 Mixed crop-livestock systems 13
 - 1.5.3 Industrial systems 13
- 1.6 Trends in science 14
- 1.7 Trends in information technologies for partnerships with NARS 16
- 1.8 Stakeholders for international livestock research 17

2 Rationale for strategic choices 27

- 2.1 ILRI in the CGIAR 27
- 2.2 CGIAR priorities and strategies for livestock research 28
- 2.3 Identification of priorities 29
- 2.4 Regional research priorities from consultations 29
- 2.5 Economic importance of livestock systems in developing country regions 33
- 2.6 The priority assessment framework 34
- 2.7 Implications of ILRI's strategic choices 36
 - 2.7.1 Choices of systems and species 37
 - 2.7.2 Charting the way forward 37

3 Strategic choices 42

- 3.1 Where and for whom ILRI will work 42
 - 3.1.1 Regional priorities 43
 - 3.1.2 Agro-ecosystem priorities 43
- 3.2 Which livestock production systems and species ILRI will address 44
- 3.3 How ILRI will work 45
- 3.4 What ILRI will do 46
- 3.5 Key research areas and strategic approaches 47
 - 3.5.1 Systems analysis and impact assessment 47
 - 3.5.2 Livestock feeds and nutrition 48
 - 3.5.3 Livestock health improvement 50
 - 3.5.4 Livestock genetics and genomics 53
 - 3.5.5 Livestock policy 55
 - 3.5.6 Livestock and the environment 58
 - 3.5.7 Capacity strengthening for livestock research 60
- 3.6 A production-to-consumption systems approach: an integrative mechanism 62
- 3.7 CGIAR systemwide initiatives 63

4 Implementing the ILRI strategy 67

- 4.1 New directions 67
 - 4.1.1 Regions, systems and species 67

4.1.2	ILRI's contribution to the CGIAR agenda	68
4.2	Defining ILRI's strategic role	70
4.2.1	Partnerships and alliances	70
4.2.2	Role for ILRI	72
4.2.3	Delivery pathways	73
4.3	Resourcing the agreed agenda	74
4.3.1	Links between priorities and resource allocations	74
4.3.2	Mobilizing financial resources	74
4.3.3	Human resources	76
4.3.4	Physical resources	76
4.4	Organization and management	77
4.4.1	Organization and structure	77
4.4.2	Institutional and programme management	78
4.4.3	Programme monitoring and evaluation	79
4.4.4	Financial management and accountability	80
4.5	Governance	80
References		81
Appendix—Issues and implications arising from external influences on ILRI's strategy		83
Glossary of terms used in the strategic planning process		91
Abbreviations and acronyms		95

The vision, mission and mandate of ILRI

Vision

A world made better for poor people in developing countries by improving agricultural systems in which livestock are important.

Mission

To help reduce poverty, hunger and environmental degradation through livestock research to enhance productivity and sustainability of agricultural systems in the developing world.

Mandate

To measurably and sustainably improve the livelihood of resource-poor livestock keepers, make animal products more affordable and accessible for the poor and conserve natural resources in developing countries through partnerships and alliances for innovative livestock research, training and information exchange.

Executive summary

Demand for meat and milk will more than double over the next two decades in developing countries. These huge increases—generated by what is being called the Livestock Revolution—provide significant research opportunities and challenges like those that marked the Green Revolution of the 1970s.

ILRI's strategy to 2010 is dedicated to making the Livestock Revolution work for the poor. ILRI's new mandate reflects this commitment to reducing poverty and to reducing malnutrition and environmental degradation.

The major factors driving the demand for livestock-source foods are population growth, increased urbanization and higher incomes. The central challenges the revolution presents for ILRI are to help ensure that resource-poor livestock keepers and consumers reap benefits from it and that the environment and public health are not hurt by it.

Two-thirds of the rural poor keep livestock and almost 60% of these are in mixed crop–livestock systems. The most recent analysis indicates that by far the largest number of the poor in developing countries are in agro-ecological zones where mixed crop–livestock systems predominate in the tropical and subtropical, humid, subhumid and semi-arid zones. Mixed crop–livestock systems in other agro-ecologies and grassland systems in all agro-ecologies are important but support fewer people. The number of poor keeping livestock in urban and peri-urban environments is growing but remains less than the number in mixed rural systems.

The livestock systems supporting most of the poor are also those where the economic importance of livestock products is the highest. Hence, the research interventions that enhance productivity and reduce costs in these systems should generate sizeable economic impact, creating new income streams for large numbers of the poor.

ILRI's primary beneficiaries are thus categorized as resource-poor livestock keepers in mixed crop–livestock production systems; also receiving attention are those in peri-urban and grassland production systems and the poor who consume livestock products.

ILRI's major focus will be on relieving the constraints to increased productivity in the mixed crop–livestock systems in sub-Saharan Africa and Asia—primarily in the subhumid and semi-arid tropics and in the tropical highlands. Secondary focus will be given to grassland and industrial livestock systems, and to Latin America, the Caribbean, West Asia and North Africa.

ILRI's primary emphasis will remain on ruminants, but it will begin to give attention to swine and poultry. The share of resources specifically focused on these monogastric animals will grow to 10%, primarily for research in epidemiology, systems analysis and policy. Of the 90% share for ruminants, half (45%) will support biological systems and policy research relevant to both large (cattle, buffalo) and small (sheep, goats) ruminants; the other half will go to species-specific research on large (30%) and small (15%) ruminants.

Where ILRI works over the next decade, and with whom, will vary depending on research opportunities and the potential for impact. To realize these opportunities, ILRI will develop new capacities and comparative advantages as new demands require.

Adopting a problem-oriented approach, ILRI will position itself in the discovery-to-delivery-to-impact continuum. It will work in international consortia and strategic alliances with a broad range of partners, to ensure complementarity and measurable and long-lasting impact. Using participatory

approaches and innovative partnerships, it will place greater emphasis on addressing the constraints to adoption of livestock technologies, working especially with national agricultural research institutes, non-governmental organizations and the private sector.

The precise role of ILRI vis-à-vis partners will vary. Partners will include international agricultural research centres, national agricultural research systems, and regional and subregional organizations from both public and private sectors. Depending on the type of research and the capabilities of collaborators and alternative providers, ILRI's role may involve leadership in which ILRI determines priorities and is a primary contributor, or its role may be facilitative, as in strengthening capacities for livestock research. A primary role will entail being principally responsible for conducting the research, whereas a catalytic role will entail providing key elements to research by a broader set of partners. A convening role will be appropriate to programmes that cut across farming systems and ecoregions but share a livestock-related concern.

From analysis of the major factors expected to influence livestock development over the next decade, the major implications for livestock research were identified. Those implications that met the following five conditions will be instrumental in setting ILRI's priority agenda: researchability, relevance to poverty reduction, current or potential comparative advantage for ILRI over alternative suppliers, a clear role for ILRI to play, and outputs that will be international public goods.

Key to ILRI's strategy is an objective, transparent, priority assessment framework for allocating resources among activities in future medium-term plans. This framework is based on *ex ante* assessment of probable economic surplus from different research investments, taking account of five criteria: contribution to poverty reduction; expected economic impact; expected environmental impact; internationality of recommendation domain; and expected impact on research capacity in developing countries.

In anticipation of a continuing shift to tightly targeted funding, this priority assessment framework will also be used to make the case for increased investments in high-priority research areas. Results of ongoing impact assessments will be used to adjust priority assessments over time to facilitate better targeting of research in the light of new opportunities and knowledge. Monitoring and evaluation will be strengthened to ensure that there are measurable indicators of success and impact in scientific, socio-economic and environmental terms.

ILRI will establish core competency in seven research and related programmes areas:

- systems analysis and impact assessment
- livestock feeds and nutrition
- livestock health improvement
- livestock genetics and genomics
- livestock and the environment
- livestock policy analysis
- capacity strengthening for livestock research

A holistic production-to-consumption systems approach will provide the essential integrating mechanisms guiding programme planning and implementation. Central to this systems approach will be multipartner, multidisciplinary teams that diagnose constraints, develop interventions from research by ILRI and others, evaluate the interventions under field conditions, and assist in further development and delivery of proven interventions to assure measurable impact.

ILRI's strategy has been developed with a pragmatic assessment of the nature and amount of resources likely to be available for livestock research. Resources directly supporting ILRI are expected to increase modestly but to be increasingly restricted to the type and location of work they support. ILRI will organize and apply its capacities in a catalytic manner to improve the effectiveness of research through strategic partnerships and through outsourcing to better-positioned alternative providers. Moreover, ILRI will devote more effort to improving public and investor support for livestock research and development.

The strategic choices and directions illustrate the evolution in approach that ILRI is taking in pursuing its mandate. From an initial emphasis in the founding strategy on broadening the scope of the livestock agenda to accommodate a new global mandate, the current strategy is characterized by the following:

- It is driven by the needs and opportunities posed by the Livestock Revolution, which anticipate a more-than-doubled demand for meat and milk in developing countries by 2020.
- It focuses on ensuring that the Livestock Revolution serves the poor.
- It has established priorities in regions, systems, species and research areas based on analysis of external influences, consultations since 1995 with key stakeholders, reviewers and CGIAR priorities.
- It explicitly considers the range of external influences on livestock research and development that will affect meeting the increased demand for livestock products.
- It employs a systematic, transparent and quantitative process of assessing priorities, which takes account of alternative research providers, ILRI's current or potential comparative advantage, and opportunities for partnerships and alliances.
- It emphasizes bringing new genetic and ecological sciences to bear on the problems in livestock productivity and environmental sustainability.
- It develops synergies within ILRI among different areas of component and systems research and with partners and allies from public and private sectors.
- It increases the emphasis on valuation, characterization and use of indigenous plant and livestock biodiversity in Africa and Asia.
- It increases the emphasis on policy research to provide an enabling environment for sustainable improvements in smallholder livestock systems.
- It increases the emphasis on strengthening livestock research capacity in sub-Saharan Africa.
- It is committed to achieving more with available resources by implementing all research through partnerships, consortia and alliances.

Preface

ILRI's strategic plan to 2010 anticipates the challenges to livestock development posed by the doubling of demand for meat and milk in developing countries over the next two decades. The development of this plan involved the active participation of external stakeholders as well as ILRI's staff, management and Board.

The planning process included analysis of the external influences likely to affect livestock development, the appropriate roles for ILRI and other research providers in the discovery-to-delivery research continuum, and the potential for impact in terms of the CGIAR goals for poverty alleviation, food security and environmental protection.

The process has been guided by agreed principles. Key among these was that the strategy be led by demand, reflected in the needs and expectations of its partners in developing countries and responding to the development priorities of the institute's investors. Other strategic principles:

- The background to the strategic choices be provided by assessing trends in livestock production, consumption and trade.
- The research agenda be defined so as to incorporate new scientific opportunities.
- The comparative advantage of ILRI be examined in formulating a clearly identifiable global livestock research agenda for the institute, including its convening role for livestock research in the CGIAR.
- The scope to enhance strategic alliances and partnerships be explicitly considered.
- There be balanced consideration of the need for greater focus, while positioning the institute to better reflect both opportunities and sources of funding.
- The complementarities and synergies required in programmes and products be recognized, if the goals of reducing poverty, improving food security and protecting the environment are to be achieved.
- An innovative approach to managing human and other resources be taken to provide the most effective leadership in livestock research for development.

The strategic planning process, detailed in Figure 2.1, defined the *key research and related areas* that address global needs and constraints to sustainable livestock development. The process included assessment of external influences and their implications for international livestock R&D, as described in Chapter 2. The key research and related areas led to *strategic approaches* for problem solving to provide opportunities for international livestock research and development. These opportunities are reflected in the *research and related outputs*, resulting from focused efforts on priority *research and related themes*.

These four elements represent the decision-making hierarchy in formulating the research agenda for ILRI. Broad strategic directions are formulated for ILRI in terms of species, livestock systems and geographic regions. Candidate research and related themes are identified to address constraints and opportunities across these three dimensions. After the candidate themes are analysed, priorities for them will be set, as described in Chapter 3. The priorities as determined will form the basis of the medium-term plan, which will include the themes with their implications for using resources. The framework for setting the priorities is included in this strategy document, although the thematic priorities themselves are not.

In Chapter 1, the strategy document first assesses the *external influences* on setting priorities for international livestock research and development. These influences include the role of livestock in poverty reduction, food and nutrition security, human health, and the trends to 2020 in livestock demand and production, especially in developing countries but also globally. The *rationale for the strategic choices* that ILRI plans to make in the first decade of the new millennium follows in Chapter 2. Chapter 3 contains the *strategic choices* themselves, and Chapter 4 concludes the document with *implementation of the strategy*.

John Vercoe
Chair, Board of Trustees

Hank Fitzhugh
Director General

Acknowledgements

The process for arriving at this strategic plan involved many people, both within and outside the institute. The various groups were

Board Management Committee on Strategic Principles

Neville Clarke (co-chair), Hank Fitzhugh (co-chair), Charan Chantalakhana, John Donelson, Cees de Haan, Margaret Gill, Jean Hanson, Tony Irvin, Hugo Li-Pun, Jim Ryan, Bruce Scott, Ana Sittenfeld, Michael Smalley, John Vercoe

Strategic Planning Steering Committee

Jean Hanson (chair), Habib Ibrahim, Jim Ryan, Bruce Scott, Jimmy Smith, Kathy Taylor, Philip Thornton

FOCUS GROUPS

Improvement of Feed Utilization and Animal Nutrition

Salvador Fernandez-Rivera (chair), Richard Bishop (rapporteur), Shirley Tarawali (rapporteur), Abdel Ghaffar Ahmed, John Brooker, C. Devendra, Jean Hanson, Pierre Hiernaux, Hans Joachim Jung, Hugo Li-Pun, Leendert 't Mannetje, Agnes Odenyo, Pascal Osuji, Jim Ryan, Bruce Scott, Zinash Sileshi, Jimmy Smith, William Thorpe, Timothy Williams, Vo-Tong Xuan, Ercole Zerbini

Improvement of Sustainable Production Systems: Improving Livestock Productivity and Natural Resource Management

Timothy Williams (chair), Mohamed Saleem (rapporteur), Abdel Ghaffar Ahmed, C. Devendra, Jean Hanson, Pierre Hiernaux, Hugo Li-Pun, Victor Mares, Paul Neate, Don Peden, Robin Reid, Jim Ryan, Bruce Scott, Jimmy Smith, Henning Steinfeld, Shirley Tarawali, William Thorpe, Vo-Tong Xuan

Improvement of Animal Health

Brian Perry (chair), Tom Randolph (rapporteur), Leyden Baker, Richard Bishop, Liz Carpenter, Paul Coleman, Guy D'Ieteren, Rob Eley, Stuart Hargreaves, Denis Hoffman, Tony Irvin, Joseph Katende, David Kennedy, Henry Kiara, Bob King, Niall MacHugh, Susan MacMillan, Phelix Majiwa, John McDermott, Travis McGuire, Declan McKeever, Bea Mertens, Subhash Morzaria, Noel Murphy, Tony Musoke, Duncan Mwangi, Jan Naessens, Vish Nene, Amos Omore, Andrew Peregrine, Prachak Poomvises, Jim Ryan, Bruce Scott, Keith Sones, Paul Spooner, Evans Taracha, Kathy Taylor, Alexander Trees

Application of Genomics and the Conservation and Use of Genetic Resources

Ed Rege (chair), Helen Leitch (rapporteur), Keith Ballingall, Leyden Baker, Richard Bishop, Ismail Boujenane, Guy d'Ieteren, Rosemary Dolan, Olivier Hanotte, Jean Hanson, Fuad Iraqi, Tony Irvin, Ramni Jamnadass, Patti Kristjanson, Sahr Lebbie, Phelix Majiwa, Declan McKeever, John Mugambi, Noel Murphy, Vish Nene, Onesmus ole-MoiYoi, Tom Randolph, John Rowlands, Jim Ryan, Bruce Scott, Kathy Taylor, William Thorpe

Integrated Systems Analysis: Livestock Policy Analysis, Decision Support Systems and Economic and Environmental Impact Assessment

Robin Reid (chair), Mohamed Jabbar (rapporteur), Steve Staal (rapporteur), Abdel Ghaffar Ahmed, David Cumming, Simeon Ehui, Patti Kristjanson, John Lynam, Nancy McCarthy, John McDermott, Margaret Morehouse, Were Omamo, Jim Ryan, Kimsey Savadogo, Bruce Scott, William Thorpe

Capacity Building, Strengthening Partnerships and Knowledge Brokering to Improve Livestock Productivity

Rob Eley (chair), Ian Moore (rapporteur), Anne Nyamu (rapporteur), Sourou Adoutan, Mukles Amarin, Jane Asaba, Norman Demers, Airedem Goncalves de Assis, Habib

Ibrahim, Willem Janssen, Magdallen N. Juma, Sahr Lebbie, Jean Ndikumana, Paul Neate, Jim Ryan, Bruce Scott, Zinash Sileshi, Michael Smalley, Vo-Tong Xuan

Management Services

Margaret Morehouse (chair), Chris Hinson (rapporteur), Norman Demers, Getachew Engida, Helen Leitch, Susan MacMillan, Declan McKeever, Ian Moore, Jacob Quaye, Jim Ryan, Bruce Scott, Antonio Silla, Steve Staal, Aguibou Tall, Kathy Taylor, Christine Thuránira, Kumar Tumuluru, Victor Umunna

External Reviewers

Eric Bradford, John Brooker, David Cumming, Paddy Cunningham, Airdem Goncalves de Assis, Willem Jansen, Lovell Jarvis, Samuel Jutzi, Peter Little, Anton Mangstl, Travis McGuire, Cyrus Ndiritu, Christie Peacock, Carlos Seré, Zinash Sileshi, Lucia de Vaccaro, Michael Young

Priority Assessment Criteria Working Group

Patti Kristjanson, Russ Kruska, Andrew Otero, Were Omamo, Philip Thornton, Tom Randolph, Robin Reid, Jim Ryan

Special thanks to Guido Gryseels, Sarah Holden, Tim Kelley, Henning Steinfeld for providing data and comments on the analysis of livestock systems and links to poverty reduction.

External Programme Management Review (EPMR)

Samuel Jutzi (chair), Robert Blake, Patricio Faylon, Guido Gryseels, Joan Joshi, Don Plucknett, Carlos Pomareda, Pammi Sachdeva, Louise Setshwaelo, Andrew Tait, Vo-Tong Xuan

Appreciation goes to the External Programme Management Review Panel and to the Technical Advisory Committee and the TAC Secretariat for their comments and recommendations on ILRI's programmes, management and strategic planning process.

ILRI Board of Trustees

Charan Chantalkhana, Neville Clarke (chair to September 1999), John Donelson, Belay Ejigu, Hank Fitzhugh, Margaret Gill, Cees de Haan (to September 1999), H. Joachim de Haas, Tetsuro Komiyama, Wilfred Mwangi, Paul-Pierre Pastoret, Amrita Patel (to September 1999), Jan Philipsson, Ana Sittenfeld, John Vercoe (chair)

James G. Ryan, Hank Fitzhugh, Jean Hanson, Ralph von Kaufmann and Bruce Scott drafted the Strategic Plan, with assistance from Keith Sones and with inputs from the focus groups, the Strategic Planning Steering Committee, the Priority Assessment Criteria Working Group and the Board Management Committee on Strategic Principles. Helen van Houten provided the technical editing.

1 External influences shaping ILRI's strategy

ILRI has developed its strategy cognizant of global trends and with an appreciation of the role livestock play in reducing poverty, improving food security and improving the environment. It is aware of the likely influences of institutional, socio-economic, scientific and policy trends on future livestock research (Delgado and others 1999; von Kaufmann in press).

In each section in this chapter, a block titled 'Issues and implications' describes the major implications for international livestock R&D. These provide the basis for consideration in Chapters 2 and 3 of the key research and related areas, strategic approaches and research outputs that will form the foundation for ILRI's strategies and priorities in the period to 2010.

1.1 Role of livestock in poverty reduction, food and nutritional security, the environment and human health

1.1.1 Poverty reduction

Over 1.3 billion people—nearly a third of the population of developing countries—live below the poverty line. The situation is worst in sub-Saharan Africa, where more than half the people fall into this category, prompting the reviewers in the Third System Review of the CGIAR (1998) to plead that special attention be given to this underprivileged region (Figure 1.1). In numbers, South Asia has the most poor people, representing 42% of the population. In the Latin American and Caribbean region, many of the 38% in poverty live in urban areas. In East Asia, only 11% of the population is in poverty, but they number 138 million people. This is closely followed by South-East Asia with 131 million poor (30%). The West Asia and North Africa region has the fewest poor—89 million or 26% of the population. Three-quarters of the poor in developing countries live in rural areas (Table 1.1).

Figure 1.1 Distribution of poor by developing country region

Table 1.1 Extent of rural poverty in developing country regions, 1994–95

Region	Number of rural poor (millions)	Share of rural to total poor (%)
East Asia	114	80.7
South Asia	417	81.3
Southeast Asia	121	82.9
Latin America and Caribbean	76	42.0
West Asia and North Africa	40	49.6
Sub-Saharan Africa	248	88.1
Total	1016	75.7

Source: Gryseels and others 1997

McCalla (1998) points out that the sources of food for urban and for rural populations are quite different. Urban populations typically obtain 90% of their food from markets, whereas rural people obtain only 40% from the market and 60% from subsistence agriculture. He asks, if the rural population markets only

some 30% of its production, how will the urban need for marketed food be met in future?

The estimated 678 million of the rural poor who keep livestock in developing countries (Table 1.2) represent about two-thirds of the rural poor, and that large proportion indicates the importance of animals to their livelihoods (Sarah Holden, *Livestock in Development*, personal communication 1999).

Table 1.2 Number and location of resource-poor livestock keepers by system

Agro-ecological zone	Category of livestock keepers who are poor (millions)		
	Extensive graziers	Mixed rainfed	Landless
Arid or semi-arid	63	213	
Temperate, including tropical highlands	72	85	
Humid, subhumid and subtropical	—	89	
Total	135	387	156

Source: *Livestock in Development* (1999)

'Landless' refers to people with no land and not to industrial production systems. The data here are revised estimates by Sarah Holden, a coauthor of the source report. Errors were detected in the original reference.

In the developing world, the mixed crop–livestock systems, especially the systems in the humid/subhumid and the arid/semi-arid tropics and subtropics, offer the best opportunity for public livestock R&D to have a significant economic impact, because the value of the animal products that would accrue from improved production and reduced costs is much greater in these two mixed systems (Figure 1.2).

Figure 1.2 Value of animal production and extent of poverty in major livestock systems of developing countries

It is in these mixed crop–livestock systems that the largest numbers of rural poor work. Focusing on improving the sustainable livelihoods of these people can do more to reduce poverty than increasing productivity in intensive industrial systems (*Livestock in Development* 1999). The majority of the rural poor in a number of the systems are livestock keepers (Figure 1.2, Table 1.2). For the developing world as a whole, the correlation is high (0.98) between the economic importance of animal products in a livestock system and the number of poor living in that agro-ecological zone (Figure 1.2).

The livestock production systems that are the most economically important and also operate where the largest number of either urban or rural poor people reside differ across the six geographic regions. The rainfed and irrigated mixed humid/subhumid tropical and subtropical systems dominate for these two criteria in East Asia, South-East Asia and sub-Saharan Africa (Figures 1.3, 1.4, 1.5). The mixed rainfed and irrigated arid/semi-arid tropical and subtropical systems are the most significant in South Asia and in West Asia and North Africa (Figures 1.6, 1.7). In Latin America and the Caribbean, the industrial systems predominate (Figure 1.8). Except in sub-Saharan Africa and Latin America and the Caribbean, there is a reasonably high correlation (0.7–0.9 versus 0.4) between the economic importance of animal products and the number of poor. Hence in the other four regions the prospect is good that focusing livestock R&D on the

systems where the economic impact is likely to be greatest will benefit the largest number of poor people.

Figures 1.3–1.8 Value of animal production and extent of poverty in major livestock systems in developing regions

The large proportion of urban poor in Latin America and the Caribbean (Figure 1.8) and the relatively high economic value of industrial animal production there may make the task of effectively targeting the poor in that region easier than in other regions, if the urban poor are significant consumers of industrial system products.

In the tropics and subtropics of sub-Saharan Africa (Figure 1.5), around 40 million rural poor are involved in the arid and semi-arid grassland livestock production system, which is high in value. Almost 100 million poor depend on the mixed humid/subhumid livestock production system, but its potential for large economic impact may be limited as the economic value of its livestock products is less.

Projections using the IFPRI impact model (Delgado and others 1999) have shown that despite the increased demand for feed grains, wheat and rice prices will decrease by 10% in real terms over the next 20 years and there will be modest declining price trends for milk and some meats. Even modest increases in the consumption of these highly nutritious foodstuffs would have a major impact on the health of poor people. Currently, more than one-third of children and pregnant and lactating women in developing countries experience mild to moderate protein-energy malnutrition (see Box 1.1). The IFPRI model clearly shows that increasing the conversion efficiency of livestock feed will help reduce upward price pressures on the feed grains that are also used as food by the poor, a further beneficial although indirect impact of livestock R&D.

Box 1.1

Animal food products and human health

Protein-energy malnutrition and deficiencies of key micronutrients are prevalent among the poor throughout the developing world. Their effects are most pronounced in children, adolescents, and pregnant and lactating women. Malnutrition in children contributes to poor growth and mental development and general ill health—outcomes with high societal and individual costs.

Animal food products such as meat, milk and eggs are compact, convenient, readily digested sources of high-quality protein and energy. They supply essential micronutrients such as calcium, iron, zinc, retinol, thiamin, and vitamins A, B6 and B12—often lacking in cereal-based diets. Increased intake of animal food products is often associated with significantly improved health.

The right combination of a variety of crop-based foods can also provide a balanced diet that supports growth and sustains health. But it is not easy for poor people to obtain the required variety of such foods that even modest increases in consumption of meat and milk can supply. The challenge is how to make these foods more available to poor people.

Source: Neuman and Harris (1999)

Issues and implications

Crop–livestock and grassland systems: *Priority should be accorded to productivity-enhancing livestock R&D for mixed crop–livestock systems to have major economic impact on the bulk of the poor in developing countries. Grassland systems offer less scope for technical interventions that can directly benefit the poor, but natural resource conservation and management and relevant policies to sustain livelihoods are researchable needs.*

Changing livestock systems: *Demographic and economic changes are causing rapid evolution of production systems within and across regions and agro-ecological zones. Setting priorities and designing research must take account of these evolutionary changes in identifying future needs. There are also opportunities for South–South exchange among regions at different stages of development.*

Distribution of the poor: *The geographical distribution of the poor, at regional, sectoral, agro-ecological and systems levels, needs to be considered, to assess priorities that will more effectively address their needs.*

Projected food price trends: *Animal-source food prices need to be monitored to establish if the projected decreases in price of animal food products actually occur and the poor have better access to meat and dairy products as a result of research-based technologies that increase productivity of systems.*

Poverty and nutritional security: *Technology and policy options are needed to optimally balance income generation with nutritional security and facilitate decisions that will improve diets in both the household and the nation.*

Non-food uses of livestock, including income generation: *Non-food uses of livestock, though declining in relative importance to food production, will continue to be important in the livelihoods of smallholders and in the sustainability of crop–livestock systems. Of particular importance is the impact on the finances and labour of women and the value of livestock as an asset in building financial security.*

The rural poor, especially women, derive a larger share of their income from livestock than do the relatively wealthy, with the possible exception of those in Latin America and the Caribbean (Delgado and others 1999). Poor people in rural areas, with little land available and poor access to capital, have few opportunities to increase their income. Thus the increasing demand for livestock products offers them a rare opportunity to benefit from a rapidly growing market. Using common-property resources—such as forages collected from roadside verges—and family labour, even the landless can produce high-value outputs for sale or the home.

A concern is that, with the prevailing trend to intensify livestock production, smallholders may be unable to compete effectively with the large, industrial enterprises. However, the cost advantage these large operators have may not be so significant if the implicit subsidies they enjoy are removed. If policies eliminate the subsidies, smallholders could compete in producing their share of the increased demand for livestock products. They can also improve their competitive edge by forming producer cooperatives (Delgado and others 1999, p 42).

Livestock, particularly ruminants, also provide households with a cash income; their products such as milk and manure can be exchanged for cereals, thus improving food security; they represent the major inflation-proof and

mobile liquid capital asset that can contribute to household survival in times of crisis; they are pivotal to farming systems of poor smallholders; and they act as a buffer against poor crop yields, especially in drought-prone regions.

1.1.2 The environment

Livestock can contribute towards environmental sustainability in well-balanced mixed systems (de Haan and others 1997). By providing draft power and manure and urine as fertilizer, livestock contribute to sustainable, intensive crop production. Owning ruminants also encourages smallholders to plant browse trees, shrubs, leguminous forages and grass—all of which control erosion, promote water conservation and increase soil fertility. That livestock overgraze and degrade arid rangelands has probably been overemphasized. Recent research suggests that the role of climatic factors has been consistently underestimated and that arid and semi-arid ecosystems are more resilient than previously thought. Inappropriate cropping on former rangelands leads to soil erosion, competition with wildlife and increased problems of food security. Marketing policies and infrastructure that will improve terms of trade for livestock will increase incomes and reduce stocking pressures.

Perhaps the greatest environmental threat that livestock pose arises from peri-urban and industrial enterprises, especially when they are situated close to urban areas. Industrial livestock units generate enormous quantities of animal waste that can exceed the absorptive capacity of the surrounding land and result in deterioration of water quality. Regulatory policies must ensure that the costs of the pollution and of controlling it are borne by those that produce it.

Policies and plans should be in place to ensure that large-scale production and processing units are located farther from urban areas and in keeping with the environment's capacity to provide the services required to deliver the inputs and manage the wastes. Generating the information required for rational and effective area-wide integration emerges as an important research topic.

Clearing and burning forests for livestock production, for example cattle ranching in the Amazon Basin, releases huge quantities of carbon dioxide into the atmosphere and causes an important loss of plant and animal biodiversity. Livestock rumen fermentation and manure generate the greenhouse gas methane, being directly responsible for 16% of its emissions worldwide. However, methane output can be reduced by having fewer but more productive animals fed on better-quality rations.

Intensification of animal agriculture tends to rely on a narrow range of improved, high-yielding genotypes. As a result, 30% of all livestock breeds are threatened with extinction. The greatest threat is in developing countries to indigenous breeds that are poorly characterized. The loss of genetic diversity in livestock may limit the capacity of animal agriculture to adapt to emerging pests and diseases and to changing market demands.

Livestock production is frequently in conflict with conserving wild animal biodiversity due to competition for feed and water, transmission of diseases and predation. However, livestock owners are not well informed about these interactions and they typically exaggerate negative impact and underestimate the positive. Knowledge of the value of wildlife for exploiting alternative forage species and for sustainable use of fragile landscapes would lead producers and landowners to well-informed and appropriate decisions on conservation and use of animal and plant biodiversity.

Issues and implications

Livestock and the environment: *Environmental impact methodologies and assessments are needed for all livestock R&D activities.*

Crop–livestock systems: *Livestock technologies need to optimize whole-farm productivity gains and environmental enhancement by integrating crop and livestock production.*

Natural resource management: *Livestock land-use practices affect air, soil, water management, and plant and animal biodiversity. Policies affecting access to common property, especially in extensive grazing areas, are critical for managing natural resources.*

Industrial and peri-urban systems: *Technological and policy options are needed to address the environmental and public health issues associated with industrial livestock production systems, which are often located in densely populated areas.*

Environment and public health: *Technological and policy options are needed that mitigate the negative and promote the positive interactions between animal agriculture, the environment and human health.*

Climate change: *Research is needed on the impact both of livestock on climate change and of climate change on the evolution of livestock production systems, and the implications both have for livestock R&D.*

Biodiversity: *The effects intensified livestock production have on the continued survival of indigenous livestock breeds and their actual and potential use, will be an important aspect. Studies of biodiversity also need to assess the impact that increased competition for land for cropping will have on animal and plant biodiversity of rangelands.*

Wildlife–livestock interactions: *Research is needed to provide information on wildlife–livestock interactions and to develop and validate tools used to support decisions on wildlife that will enable resource-poor livestock keepers to make better decisions and obtain greater value from wildlife and thereby contribute effectively to conserving wild animal biodiversity.*

1.1.3 Human health

Modest increases in consumption of meat and milk will improve nutritional status of the poor by providing the protein and micronutrients that are currently deficient. Even by the year 2020, consumption levels of meat and milk in developing countries are projected to be less than half the present developed country average, and lack of access to animal products by the poor is a major concern (see Box 1.1).

Zoonotic diseases—the diseases that can spread from animals to humans—are of special concern where large concentrations of animals are kept near people. This is a common situation in peri-urban small-scale systems and the rapidly expanding industrial sector. Small-scale producers in the developing world must comply with stringent health regulations if they plan to compete with producers in developed countries. Export markets have well-run monitoring and surveillance operations that effectively enforce public health regulations. Even so, pathogens borne by animal foods are reported to be responsible for over 12 million infections and 3900 deaths per year in the United States alone (Delgado and others 1999). Recent examples of new threats such as BSE (bovine somatotrophic encephalopathy or ‘mad cow disease’) in Europe, human-infective avian flu in Hong Kong and viral encephalitis in Malaysia have dramatically

illustrated the danger. Residues of veterinary drugs and insecticides in meat and milk are an additional problem, exacerbated by suppliers' tendency to ignore recommended withdrawal periods.

Issues and implications

Impact of improved nutrition, especially on women and children: *There is a need to monitor the effect that changes in the price of livestock products have on consumption patterns and human nutritional status, especially of women and children.*

Zoonoses: *Regulatory policies and technological solutions are needed to minimize the threat of zoonotic diseases, especially those associated with increased intensification of peri-urban livestock production systems.*

Food safety: *Food safety and hygiene issues associated with industrial and smallholder production systems, food processing, and drug and pesticide residues in livestock products need to be considered in designing livestock R&D strategies.*

1.2 Livestock demand trends

Over the next 20 years there will be a massive increase in demand for food of animal origin, with virtually all the increased demand coming from developing countries. This increase in demand will arise from a combination of population growth—an extra 2.5 billion people to feed by 2020—and changes in the diet of billions of people. Increasing urbanization—more than half the people in developing countries will live in towns and cities by 2020—and growth in people's income will drive the change.

This trend continues the process that is already occurring: on average people in developing countries have increased their consumption of meat by 50% over the past 10 years (Delgado and others 1999). There are important regional differences, with the greatest increases seen in regions where incomes grew most rapidly. In general, Asia¹ witnessed the greatest increase in per capita consumption of foods of animal origin, while in sub-Saharan Africa consumption remained static or even declined. In the future the rate of increase in demand for livestock products will be highest in the densely populated areas of Asia and in sub-Saharan Africa, although the latter starts from a low base.

The magnitude and significance of the projected increases in demand for livestock products in developing countries over the next 20 years has prompted the coining of the term 'Livestock Revolution' to describe this process (Delgado and others 1999). The implications, opportunities and challenges represented by the Livestock Revolution are considered by some to be just as great as those that accompanied the Green Revolution of the 1970s.

Currently the disparity in consumption of livestock products between the developed and the developing countries is markedly great. People in developed countries typically consume up to four times as much meat and six times as much milk as those in developing countries (see Figure 1.9). While demand for meat in the developed countries is projected to grow only marginally over the next 20 years, demand in developing countries is expected to grow at 2.8% per year (Delgado and others 1999). This will increase the annual demand for meat in

¹ 'Asia' as used in this document includes East Asia, South Asia, South-East Asia; it does not include West or Central Asia.

developing countries from 89 million tonnes in 1993 to 188 million tonnes by 2020—that means an additional 100 million tonnes of meat will be required every year to meet this demand. Two-thirds of the increased demand will be for pork and poultry meat, but again regional differences will be important, partly due to cultural factors (see Table 1.3).

Figure 1.9 Per capita consumption of meat and milk, 1983, 1993 and 2020

Table 1.3 Regional projections of total demand and consumption of livestock products (million tonnes)

Region	Sheep		Beef		Pork		Poultry		Milk	
	1993	2020	1993	2020	1993	2020	1993	2020	1993	2020
East Asia	2	2	3	7	31	65	7	18	9	19
South Asia	1	3	3	8	0	1	0	2	69	201
South-East Asia	0	0	1	3	3	7	3	6	5	11
Latin America & Caribbean	0	1	10	18	3	6	7	14	46	77
West Asia & North Africa	2	4	2	5	0	0	3	6	23	51
Sub-Saharan Africa	1	2	2	6	1	2	1	2	14	31
Developing	6	12	22	47	39	81	21	49	168	391
Developed	4	4	32	36	38	41	26	34	245	263

Source: Delgado and others 1999

Issues and implications

Regional demand patterns: *Demand growth for meat and milk is expected to be greatest in Asia and sub-Saharan Africa. These regions deserve a high priority for livestock R&D if appropriate supply responses are to meet the demand challenge.*

Demand growth for pig and poultry products: *Demand growth for pig and poultry products will exceed that for other meats and will be primarily outside of sub-Saharan Africa. The interests of smallholder pig and poultry keepers require research to ensure that they participate in the economic benefits this demand growth will generate.*

In a similar situation for milk, an annual increase in demand of 3.3% in developing countries is anticipated (Figure 1.9 and Table 1.3) (Delgado and others 1999), although again there will be important regional differences. Between 1993 and 2020 the annual demand for milk in developing countries will increase from 168 to 391 million tonnes.

Despite the rapid increase in urban populations, most of the poor are rural dwellers, and this is still expected to be the case in 2020. Livestock provide income-generating opportunities for the rural poor and therefore offer an escape route from poverty. Livestock provide opportunities for trading in eggs, dairy products, and woollen and leather goods—trade that is especially important to women.

Increased production of livestock products, whether from smallholder systems or otherwise, will lead towards decreasing relative and perhaps absolute real

prices for animal-source foods, which will benefit both rural and urban poor. The more income, the more meat consumed (Figure 1.10), and an increase in income has a proportionally larger effect in the poorest countries.

Figure 1.10 The relationship between meat consumption and income

1.3 Livestock production trends

Massive increases in demand for animal food products offer similarly great opportunities for livestock producers in the developing countries, where relatively few livestock products are traded internationally. As over the last decade, internationally traded meat has remained stable at 9–10% of total global production (McCalla and de Haan 1998), much of the additional demand will likely be met from domestic production. What proportion of this additional production takes place on smallholders' farms will be a central issue of the Livestock Revolution and will determine whether the poor reap their share of the benefits that will accompany the increase.

By 2020 it is projected that livestock producers in developing countries will annually produce close to 100 million tonnes more meat than they did in the early 1990s (Figure 1.11). Generally, livestock production is increasing more rapidly in industrial systems close to urban centres than in more traditional systems, and this trend raises important environmental and public health issues. But there are, and will continue to be, important regional differences in the trends in livestock production in both species and production systems. Also, ruminants produce both milk and meat, and the proportions can be changed by livestock keepers, depending on relative price movements. Hence production responses can be flexible.

Figure 1.11. Projected trends in production of various livestock products, 1983, 1993 and 2020

Pork and poultry meat production will expand fastest overall, especially in the more affluent parts of Asia, with concomitant increases in requirements for feed grains. Grass-fed beef will continue to be the most important meat in Latin America and the Caribbean. Increased beef production in West Asia and North Africa will be dependent on doubling inputs of feed grains, due to lack of sufficient pasture. In sub-Saharan Africa, large ruminants will mainly supply the increased demand for meat.

The trends in livestock production in sub-Saharan Africa and South-East Asia are very different. Increased production of meat in sub-Saharan Africa will continue to come primarily from cattle, sheep and goats. These ruminants will be reared either on rangelands, especially in arid and semi-arid areas, or in mixed farming systems in higher-potential areas. In South-East Asia, the trend is away from production of pork and poultry in traditional farmyard and small-scale peri-urban systems, towards industrial systems that depend on imported feed grains.

Improving animal health and nutrition and enhancing genetic potentials will be the major paths towards improving productivity per animal. With fixed or even decreasing land area for grazing and for producing feed and food crops, increasing the number of animals is not a sustainable option. However, smallholders must be made able to compete with the industrial producers.

Issues and implications

Making the Livestock Revolution work for the poor: *Technology and policy options are needed to influence the course and direction of the Livestock Revolution to ensure that the poor reap their share of the available benefits, both as producers and as consumers.*

Livestock demand and production trends: *To guide decisions on priorities for livestock R&D, continual monitoring and analysis of demand and supply for livestock products are needed because of uncertainties about national and regional economic development, trade relationships, consumer capacity to pay, and competition for the required resources.*

Trade in livestock and livestock products: *Policy options are needed to allow resource-poor livestock keepers to engage more effectively in trade of livestock and livestock products and to identify and remove national and international constraints to trade.*

Need to exploit livestock genetic diversity: *Concerns about chemical drug resistance imply that the alternative of building genetic resistance to diseases and pests needs to be explored further.*

As production systems intensify, farmers tend to invest more capital per animal to purchase highly productive exotic breeds. The investment is justified in terms of the yield potential. However, an animal's ability to survive and be productive is a function of its state of health, and most high-yielding exotic breeds are poorly adapted to withstand diseases associated with intensification and common endemic diseases of the tropics. This raises the importance of disease control as it relates to the emergence of more smallholder farmers opting to intensify and keep fewer numbers of high-yielding animals rather than more low-producing animals.

The current dependence of intensive systems on drugs and chemicals for disease control is a matter of widespread concern because of the potential adverse effects on human consumers and the environment. Increased drug resistance among common disease organisms and parasites also concerns producers. Enhancing the genetic capacity of high-potential livestock to withstand the disease and parasite challenges in developing countries suggests an option for reducing the use of drugs and chemicals to control disease. Emerging techniques for animal breeding provide opportunities to selectively combine traits for disease and parasite resistance with the genetic potential for higher productivity. Disease control may also be achieved through better delivery of currently available vaccines and development of new vaccines for diseases for which current control methods are no longer sustainable.

The trends in production and increased concentrations of animals will increase the importance of controlling the diseases that impede trade. In addition to meeting disease control standards, exporters of livestock products will have to comply with the veterinary hygiene and food safety standards of the importing countries.

1.4 The productivity challenge

If livestock production is to keep pace with demand (Table 1.4), the imperative is to enhance productivity per animal. For developing countries as a whole, the difference between projected demand growth and recent productivity growth, termed the demand–productivity growth gap, is positive for all products. It is

largest for poultry and beef, then for pork and then milk. Regions differ in terms of the species where the gaps are greatest. The gap is in part caused by the failure to get innovative technologies adopted, and this needs to be improved, especially with regard to promoting environmentally benign technologies that will make smallholders competitive.

Issues and implications

Demand–productivity growth gaps: *Emphasis on poultry and beef research is required in developing countries if demand is not to substantially outstrip production in the next 20 years, causing inappropriate responses with adverse consequences for the poor and the environment through pollution from animal wastes and increased pressure on land resources. Sub-Saharan Africa is at greatest risk of a demand-and-supply imbalance for all animal products.*

Technology exchange: *Ineffective delivery and adoption of available and prospective technologies has been identified as a severe constraint to improving livestock productivity. The reasons for poor past performance need to be identified and innovative delivery pathways developed to overcome these constraints. South–South exchange needs to be encouraged.*

1.5 Evolution of livestock systems

Changing livestock production systems will generate new challenges and opportunities for livestock research and development, particularly in the key areas of animal health, nutrition, the environment and policy.

1.5.1 Grazing systems

Issues and implications

Grazing systems: *Policies and technologies are needed to ensure that grazing lands, which cover 25% of the earth's land surface, provide for the people who are dependent on them and at the same time fulfil their vital environmental roles in biodiversity, soil and water conservation, and carbon sequestration.*

Stratification of production systems: *Policy and trade environments should encourage carrying out each of the different phases of livestock production under the most appropriate system and in the most appropriate location; this could include integrating wildlife with domesticated livestock.*

Grazing systems currently cover almost 25% of the world's land area and produce 10% of its meat requirements. Throughout the world, traditional grazing areas are coming under increasing pressure due to the growth in human population and subsequent competition to use the land for other purposes. These rangelands have proven to be more resilient than originally believed, and breeding and raising livestock in the drier areas and finishing them in more intensive systems closer to the final markets may offer the best option to increase productivity and the best opportunity to improve pastoralist income. There is also scope to exploit wildlife on rangelands by marketing bush meat and by deriving income from tourism.

Table 1.4 Recent (1982–94) productivity and projected (1993–2020) demand growth rates (% per annum)

Regions	Sheep		Beef		Pork		Poultry		Milk	
	Productivity growth ^a	Demand growth ^b	Productivity growth	Demand growth	Productivity growth	Demand growth	Productivity growth	Demand growth	Productivity growth	Demand growth
East Asia	n.a.	0.0	3.8	3.2	1.5	2.8	2.4	3.6	0.0	2.8
South Asia	n.a.	4.2	1.5	3.7	0.0	18.6 ^c	0.8	21.7 ^c	3.9	4.0
South-East Asia	n.a.	0.0	0.9	4.2	0.8	3.2	–0.3	2.6	2.4	3.0
Latin America and Caribbean	n.a.	18.6 ^c	0.2	2.2	0.5	2.6	1.1	2.6	0.7	1.9
West Asia and North Africa	n.a.	2.6	2.7	3.5	0.1	0.0	0.2	2.6	1.5	3.0
Sub-Saharan Africa	n.a.	2.6	–0.5	4.2	0.1	2.6	–0.1	2.6	0.6	3.0
Developing countries	n.a.	2.6	0.5	2.9	1.2	2.7	0.8	3.2	1.9	3.2
Developed countries	n.a.	0.0	0.9	0.4	0.4	0.3	0.8	1.0	1.3	0.3

Source: derived from Delgado and others (1999)

n.a. – not available

^a Productivity growth is per animal^b Demand growth is expressed on a total basis, not per capita^c These growth rates were from a very low initial base, which inflates the figures

1.5.2 Mixed crop–livestock systems

Mixed crop–livestock systems provide over 50% of the world's meat and over 90% of its milk (CAST 1999). They are the most common form of livestock operation in developing countries. Also, mixed systems contain most of the rural poor and some 57% of the livestock keepers who are poor (see Section 1.1). As population density increases and less land becomes available, the general trend is for crop and livestock activities to integrate. Continuing population growth will require further intensification in these mixed systems, and livestock, especially ruminants, will continue to play a vital role—providing draft power to increase efficiency and minimize human drudgery, manure to maintain soil fertility, animal food products to improve nutritional status, and opportunities for generating more income. Throughout most of the developing world, crop–livestock systems involving ruminants will emphasize milk rather than meat production because this option gives better returns to family labour and provides highly desirable daily incomes.

Issues and implications

Integration of crop and livestock production: *Because of increasing land pressure, research to enhance complementarities between crop and livestock production has high priority.*

1.5.3 Industrial systems

Globally, close to 80% of poultry and 40% of pork are produced in industrial systems (de Haan and others 1997), although very little beef and mutton or dairy production is industrial. The growth of these systems has major implications for trade in feed grains, as livestock now consume a third of the world's grain supplies. Close to 300 million tonnes more cereals will be fed to livestock in the year 2020 than was fed in the early 1990s. This growing demand raises concern about competition with humans for grain and the need to improve livestock conversion efficiencies (see Box 1.2). Another concern is for the welfare and security of smallholder producers, who may become contract suppliers for finishers and processors.

Issues and implications

Competition and integration between smallholder and industrial systems: *Policy and technology options are needed to improve equity and enable smallholders to compete or integrate effectively with more intensive production systems.*

Vertical integration with processors: *Options are needed to facilitate cost-effective integration of smallholders and animal food processors, for example, by promoting participatory, collective-action organizations such as smallholder dairy cooperatives.*

Increased use of feed grains: *The effects on world cereal markets of increased demand for feed grains need to be assessed to minimize the risk of worsening overall food security of poor people and increasing competition for land and other resources for animal feed versus human food grains.*

Box 1.2**Production efficiencies of animal foods**

Many ruminants, especially those in the developing world, consume mostly or wholly materials not edible by humans, such as grasses, herbaceous legumes, crop residues and by-products of food processing. For every 100 kg of human food produced from crops an average of 37 kg of by-products is produced—waste material that ruminants can convert into human-edible food. Also, ruminants can be maintained in areas that are too arid, steep, rocky or infertile to permit crop production. Globally 3.35 billion hectares, or about 25% of the world's land area, is grazed by livestock, and most of this land could not produce human food any other way. Cattle, buffalo, camels, sheep and goats can therefore produce high-quality foodstuffs without competing with people.

The efficiency with which livestock convert feed grain into meat is also steadily increasing. Between 1983 and 1993, meat produced per unit of feed grain consumed increased by about 15%. However, there is room for further improvement, particularly in the developing world, where on average, conversion rates are only half as efficient as in developed countries.

Source: CAST (1999)

The large amount of wastes that animals produce, often close to urban centres, raises serious environmental and public health concerns. If new policies and regulations address these problems, the cost of production in large-scale industrial systems will rise and the sector may lose its competitive advantage over small-scale systems that pollute less. The same applies to large-scale abattoirs and tanneries.

1.6 Trends in science

If the challenges of the Livestock Revolution are to be met, equally revolutionary methods must be used to make livestock production sustainable, to improve policies and to promote better application of existing technologies. A 'business as before' approach is unlikely to meet the projected demand. Fortunately, revolutions are also occurring in science and technology. Successfully applying their products—from advances in genetics and genomics, the rapidly developing field of biotechnology and the equally promising field of informatics—has enormous potential for intensifying livestock production in a sustainable way.

Rapid advances in genetics over the past decade have been fuelled by investments in human genetics and genomics. Livestock researchers are taking advantage of the techniques developed for human medicine in many ways, particularly in mapping livestock and parasite genomes. In return, research on the genetic basis for livestock diseases will provide information and disease models that will be immensely useful for human medicine. For example, the blood parasite *Theileria* (*T. parva* causes East Coast fever in cattle) is similar to the malaria parasite *Plasmodium*. Thus insights into the functioning of mammalian immune systems arising from research on *Theileria* are of great interest to human medical researchers. Also, as *Theileria* causes blood cells to multiply in a manner similar to the way leukaemia does, other potentially important information may be gained that can be applied to human medicine.

Issues and implications

Trends in science: *New science enables new approaches to solving the complex problems limiting livestock productivity in developing countries. Large-scale industrial systems will be served by the for-profit sector and often will transfer technologies from systems in developed countries. Publicly supported research drawing on new science can serve the poor and protect the environment.*

Effect of new science on old problems: *Effective application of new science options may radically increase the probability of successfully resolving long-standing problems.*

Access to new science: *The existence of proprietary technologies in 'new science' acts as a constraint to the wider use of these technologies in developing countries, especially by NARS. A body to act as broker is needed to negotiate equitable access for developing countries.*

Genetically modified organisms: *The international community has growing concerns regarding genetically modified organisms. Their precise definitions must be clear and the ethical issues involved well spelled out.*

Intellectual property rights: *To protect public interests and to ensure that the private sector is involved where deemed necessary, international centres need effective policies and protocols to protect intellectual property. This protection may require greater use of defensive patents than envisaged even recently.*

Biosafety: *International centres will continue to carry out their research agendas with due diligence to ensure that they are following international standards of biosafety.*

Animal welfare: *Recognizing the concerns of the international community, research involving live animals must meet the highest international standards for animal welfare.*

Modern biotechnology has provided a better understanding of the molecular basis of genetic variation and offers a suite of potentially useful techniques. Examples of what biotechnology can offer are 1) developing livestock that are both more productive and better adapted to particular environments; 2) identifying candidate antigens for developing vaccines to control key livestock diseases; 3) developing sensitive and specific diagnostic tools for use in epidemiological studies and disease control programmes; 4) identifying genetic markers for the feed quality traits desirable in forages and crop residues, which can be used in plant breeding; and 5) manipulating rumen microflora to improve use of locally available feeds.

IARCs are well placed to capture the enormous potential of modern biotechnology and help ensure that its impact is felt in developing countries. They are also well positioned to develop collaborative research programmes with advanced research institutes throughout the world that complement the work of developing country agricultural research systems. The resources and comparative advantages of IARCs, applied strategically, will add value to the total investment in international agricultural research. Delivery of research products through appropriate partners will ensure that the full potential of these products will be realized.

A range of powerful new tools and approaches is now available for more effective collection, analysis and interpretation of data. These tools include geographic information systems, satellite imagery, systems analysis and spatial analysis—for example, to map poverty—to determine recommendation domains.

Refining, validating and eventually applying these tools and approaches will make setting research priorities and assessing impact of the resultant approaches much more effective.

Although ILRI's sights are firmly fixed on the public-good goals of reducing poverty and increasing food and nutrition security, the international community—including the CGIAR, international agencies, and both donor countries and developing countries—have concerns that span a wide range of thorny issues. Items on the agenda that must be addressed include use of genetically modified organisms and related food safety standards, intellectual property rights, biodiversity, animal welfare, biosafety, environmental concerns including climate change, and international trade. Assuaging these concerns while at the same time achieving the stated goals is a real challenge, influencing policy and affecting public relations.

Some research products, such as vaccines, call for commercial partners who can develop and manufacture a product and deliver it to the farmer. Partnership in turn means that the research products must be securely protected by patents. In view of the high cost of developing these products, a commercial partner will demand exclusive licensing agreements. As patenting is increasingly applied to genetic information, defensive patenting may be necessary to ensure that information that CGIAR research generates stays in the public domain.

1.7 Trends in information technologies for partnerships with NARS

Many NARS in developing countries lack ready access to the wealth of information and knowledge on livestock production and related fields. Their access to journals and recently published books is often poor. Net-based technologies offer an effective way of overcoming these shortcomings.

International livestock R&D already uses the power of the Internet as a way to share and obtain information and expert advice within the international community. The Internet will also revolutionize livestock R&D in developing countries. Although Internet access within many developing countries is poor today, especially in sub-Saharan Africa, initiatives and commercial ventures are changing this situation. We can safely assume that by 2010, NARS scientists will have easy access to all the existing and many new services from the Internet.

Issues and implications

Net-based technologies: *Opportunities arising from advances in communication and Net-based technologies can be used to deliver cost-effective training and information services.*

Information technologies will affect the way NARS will seek and share information and the way they will organize and manage their research. They will improve the poor links in the research–extension–farmer chain and extend Internet services to rural populations. Already multipurpose community telecentres have been established in Benin, Mali, Mozambique, Tanzania and Uganda; similar initiatives are under way in other regions of the world. Unless NARS and extension agents make themselves partners in these new opportunities, farming communities may use the Internet directly to seek and find solutions to problems of improving farm production.

The Internet will also provide NARS with new tools for building and strengthening their R&D capacities. Electronic distance learning on the Internet,

through the African Virtual University and initiatives like ‘Learning without Frontiers’ and ‘Creating Learning Networks for Teachers’, demonstrate the way forward.

1.8 Stakeholders for international livestock research

Disparate are the roles and expectations of the many partners and stakeholders in international and national livestock R&D (see Table 1.5). However, ILRI expects to respond to them in designing its strategy and in defining its responsibilities and roles. Principal stakeholders include beneficiaries, partners, allies, alternative research suppliers, clients and investors. Principal beneficiaries from international livestock research that addresses the needs of the poor in developing countries will be those whose livelihood is improved by keeping more productive livestock and those whose nutritional well-being is improved from an increased supply of affordable and accessible meat, milk and eggs. On a broader level, research that mitigates environmental pollution and degradation will benefit society worldwide.

The impact that international livestock research makes will depend both on the critical mass of its scientific and institutional capacity for the research and on the development and delivery of the products from the research. This critical mass, essential for the success of the discovery-to-delivery-to-impact continuum, involves partners, allies, alternative suppliers, investors and the beneficiaries themselves. The CGIAR represents only 4% of the annual investment in agricultural research for development. Thus IARCs such as ILRI will generate the most impact by working with and through partners and allies supported by the 96% of the total investment.

Given the pressing and urgent needs that the Livestock Revolution imposes, research oriented towards livestock development cannot be deemed successful unless its products reach the ultimate beneficiaries quickly. ILRI's impact will increasingly depend on the efforts of NARS, NGOs and the for-profit private sector.

Issues and implications

Public vs private goods: *International centres are primarily involved in generating international public goods; however, in some areas (for example, diagnostics, vaccine development), involving the private sector may be beneficial. But limited markets consisting chiefly of poor people may mean that centres will have to orchestrate creative incentive arrangements to interest the private sector in developing and delivering products.*

The traditional *modus operandi* for international centres is to deliver their research products through national research and extension services. The capacity of NARS varies enormously from country to country and region to region. Especially in sub-Saharan Africa, the capacity of national research and extension services has failed to keep pace with the increasing need for livestock research and development. The gap this creates in the discovery-to-delivery-to-impact chain must be closed by strengthening the capacity of NARS and extension services through training and providing information. In addition, ILRI must forge new partnerships with NGOs and must work to involve the private sector more. These new partnerships bring new challenges. ILRI must rationalize the focus on international public goods with the need to protect intellectual property

rights, to ensure that research products are developed and delivered and that those products serve the needs of the poor.

Table 1.5 Stakeholder roles and expectations from international livestock research

Stakeholder	Role	Expectation
The hungry and poor in developing countries	Serve rural poor and low-income consumers, who are the primary beneficiaries	Improved welfare due to availability of and access to adequate quantities of affordable, wholesome, safe food
Resource-poor smallholder livestock keepers	Enhance role as principal producers of livestock products and clients for research-derived interventions and products	Increased sales of meat, milk and eggs, generating income to improve livelihood of smallholder producers and bring them into the market economy
Natural resource managers, including farmers and pastoralists	Increase offtake of livestock products by increasing productivity, reducing wastage and protecting natural resources	Adoption of proven technologies and enabling policies that encourage innovation and sustainable natural resource management
National agricultural research and extension agencies	Working as both partners and clients, ensure that research products serve needs in developing countries	Application of knowledge and technology in animal agriculture to raising incomes and producing food and fibre in developing countries
Developed country research institutes	Serve as alternative suppliers and partners for demand-led upstream research	Research products resulting from ILRI's collaboration with NARS and other partners
International agricultural research centres	Through strategic and applied research and capacity building, address constraints to sustainable livestock development	Research and capacity-building inputs that enhance the productivity of the collective efforts of other research providers
Private sector for-profit organizations	Serve as alternative suppliers and allies in developing and delivering profitable products from research	Availability of affordable purchased inputs and markets for farm products and processed food
Non-governmental organizations	Serve as facilitators, transfer agents	Implementation of improved practices, on the farm, regionally and nationally
Development policy- and decision-makers	Promote the sustainable livelihoods of smallholders and low-income consumers with enabling policy environments and support systems	Availability of policy options and validated alternative technologies for enhancing livestock production and trade
Development banks and agencies	Enhance livestock development through investment and technical assistance	Sustainable livestock development contributing to local and national economic development
Investors	Provide capital and credit for agriculture and rural development, enabling use of research products	Investment strategy; based on or due to added impact of investment in R&D

Recognizing the need to focus resources and build critical mass, NARS in all developing regions are joining in regional associations to set priorities and to coordinate and mobilize resources for research on common regional issues. Examples are the Asia Pacific Association of Agricultural Research Institutes (APAARI) and the Proyecto Cooperativo de Investigación (PROCI) in Latin America. In Africa, the Forum for Agricultural Research in Africa (FARA) has three subregional members, the Association for Agricultural Research in East and Central Africa (ASARECA), the West and Central African Council for Agriculture Research and Development (WECARD/CORAF) and the Southern African Development Community– Southern African Centre for Cooperation in

Agricultural Research (SADC/SACCAR). IARC agendas will increasingly coordinate with those of such organizations—as indeed will the CGIAR’s overall agenda through links with the Global Forum for Agricultural Research (GFAR), to which the regional organizations belong.

International agricultural research is primarily funded by countries of the Organization for Economic Cooperation and Development (OECD) and development agencies and foundations closely allied with those countries. Hence the investors tend to have the same goals and limitations. The overall goals in recent years have not varied much—reducing poverty, achieving food security and protecting the environment. However, in recent years there have been important changes in emphasis, with poverty reduction becoming paramount. Food security is extending to include nutritional security and rural livelihoods. Conservation of the environment has the dual goals of reducing negative factors such as the accumulation of greenhouse gases and encouraging positive factors, especially improving the management of natural resources such as soil and water.

Issues and implications

International conventions: *International centres have an obligation to help accomplish the goals and objectives of international conventions that CGIAR members and their host governments have endorsed.*

Capacity of NARS: *NARS must be strong to establish effective research partnerships and deliver research products in a timely way. International centres have an important role to play in strengthening and building the capacity of NARS.*

New partnerships: *In response to international developments, international centres need to work with a wider range of partners, including NGOs, the private sector, and regional and subregional organizations.*

Changing investor expectations: *To attract sufficient investment, researchers will have to demonstrate that their products contribute to the investors’ goals and objectives. The paramount goal at this time is to reduce poverty. Distributing income and wealth more equitably, providing nutritional security and protecting the environment are additional important goals. Investors also urge that partnerships be forged and institutional capacity be built to increase impact.*

Balanced portfolios: *Given that the bulk of research funding comes from development agencies with short-term objectives, research institutes must develop a mix of research activities in which important long-term, high-impact research is deemed credible and is underwritten because of the outflow of short- and medium-term research products.*

The funds available for development, including research for development, have declined. This decline has been accompanied by greater insistence on accountability and evidence of impact. A means to these ends is proportionately greater reliance on short-term targeted funding. These trends constrain funding for long-term, strategic and higher-risk research. Another consequence has been increased competition for funding. The advanced research institutes (ARIs) are increasingly seeking alliances with NARS in developing fundable research projects. IARCs will, therefore, increasingly work in consortia of ARIs and NARS towards common objectives. This will increase the impact of the overall investment in international agricultural research.

Members of the CGIAR and the host countries in which international agricultural research is conducted have endorsed a series of international undertakings and conventions. Prominent among these are the pledges made at the Earth Summit and Agenda 21 on the environment and at the World Food Summit, to halve the number of undernourished people by 2015. The conventions include the Convention on Conservation of Biodiversity, the Convention on Combating Desertification and the Kyoto Agreement on Climate Change. International agricultural research institutes are committed to working toward achieving the goals of these international agreements.

see file figs. 1.1 –1.11 – LAN for figures for this chapter; insert as pages 21–26

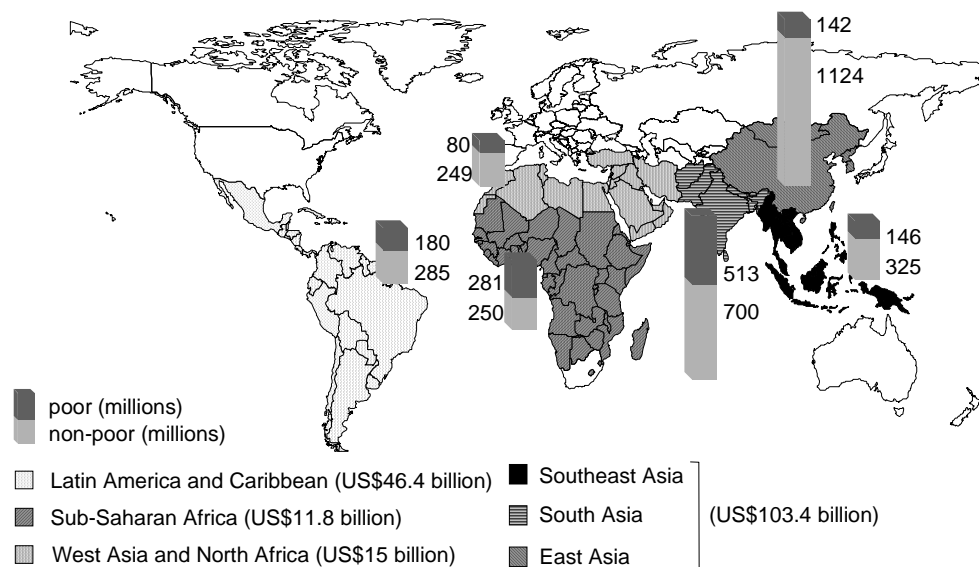


Figure 1.1 Distribution of poor by developing country region (millions) 1994–95 (Gryseels and others 1997). Figures in parentheses are the total value of livestock products (calculated by ILRI from Seré and Steinfeld 1996; Delgado and others 1999)

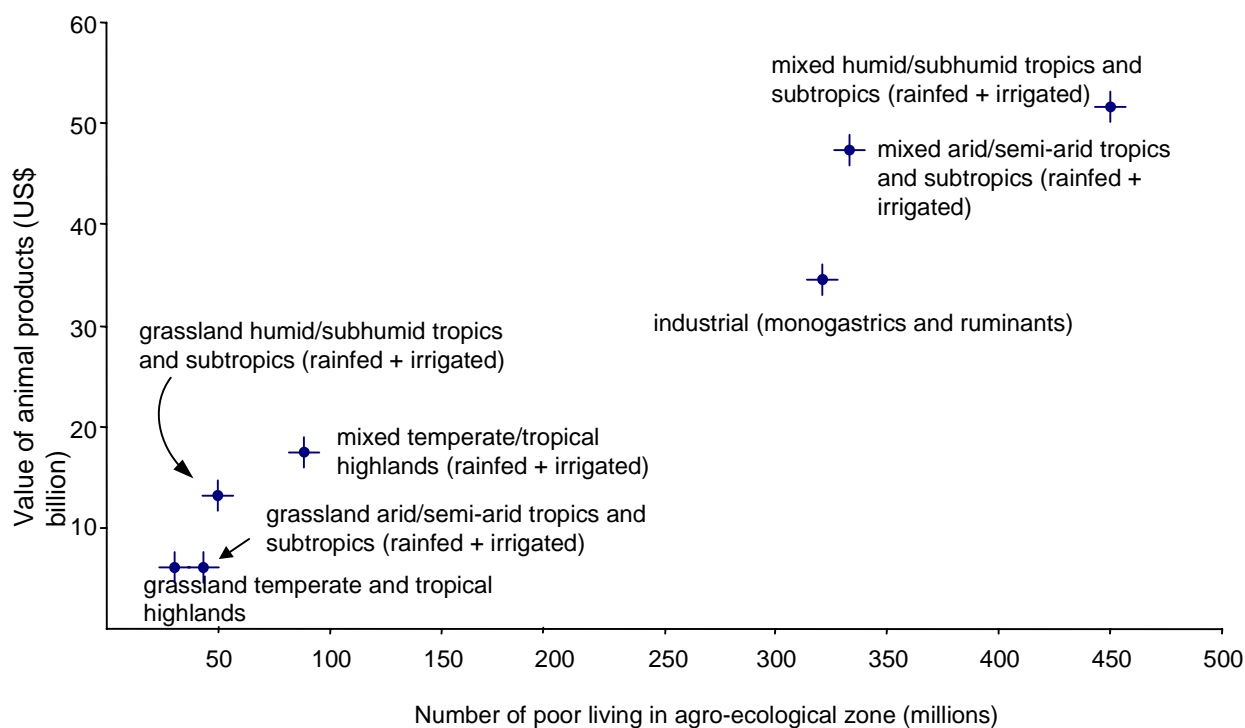


Figure 1.2 Value of animal production and extent of poverty in major livestock production systems in developing countries. Sources: Animal production derived from Seré and Steinfeld (1996 p 67–78), 1992–94 prices from Delgado and others (1999 p 35), poverty from analysis by ILRI of data provided in Gryseels and others (1997) and Seré and Steinfeld (1996), which is described in a forthcoming ILRI monograph in the Impact Assessment Series. Animal products include milk, beef, buffalo meat, sheep and goat meat, poultry meat and eggs (Ruiz and others 1995, Seré and Steinfeld 1996). For the industrial systems the number of poor refer to the total urban poor; for all others the number of rural poor are shown.

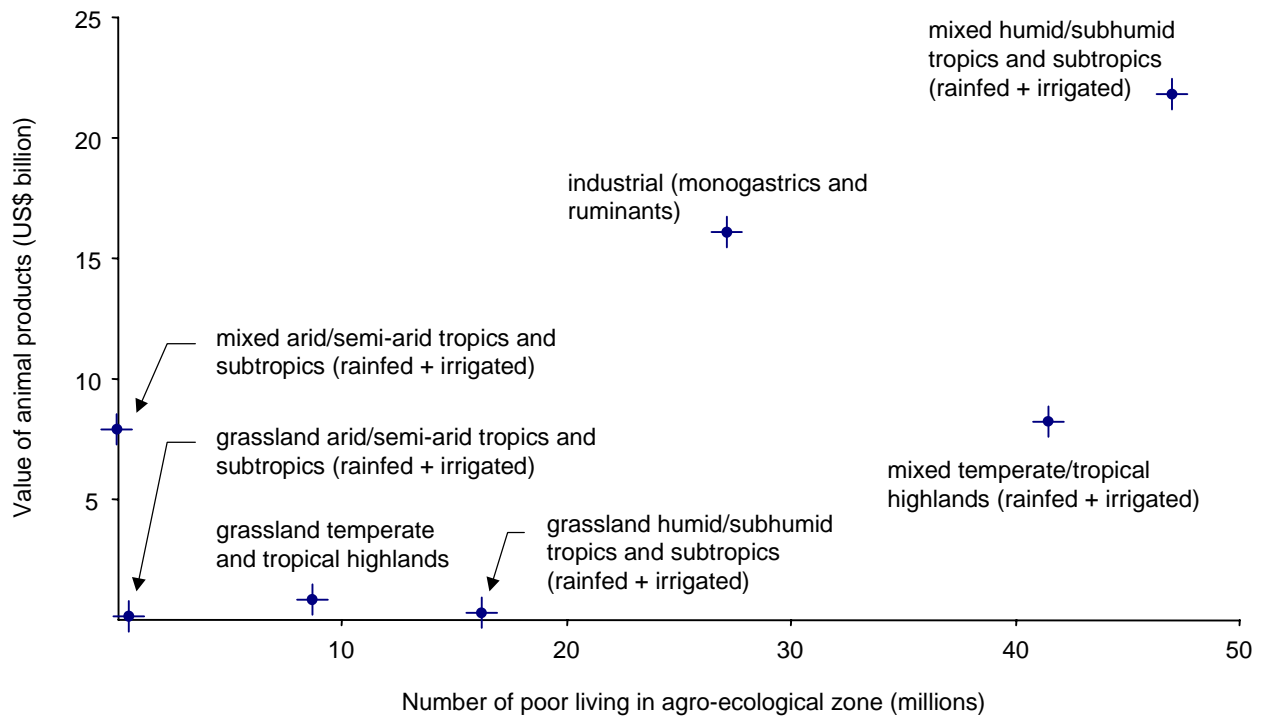


Figure 1.3 Value of animal production and extent of poverty in major livestock production systems in East Asia. (For sources, see caption for Figure 1.2.)

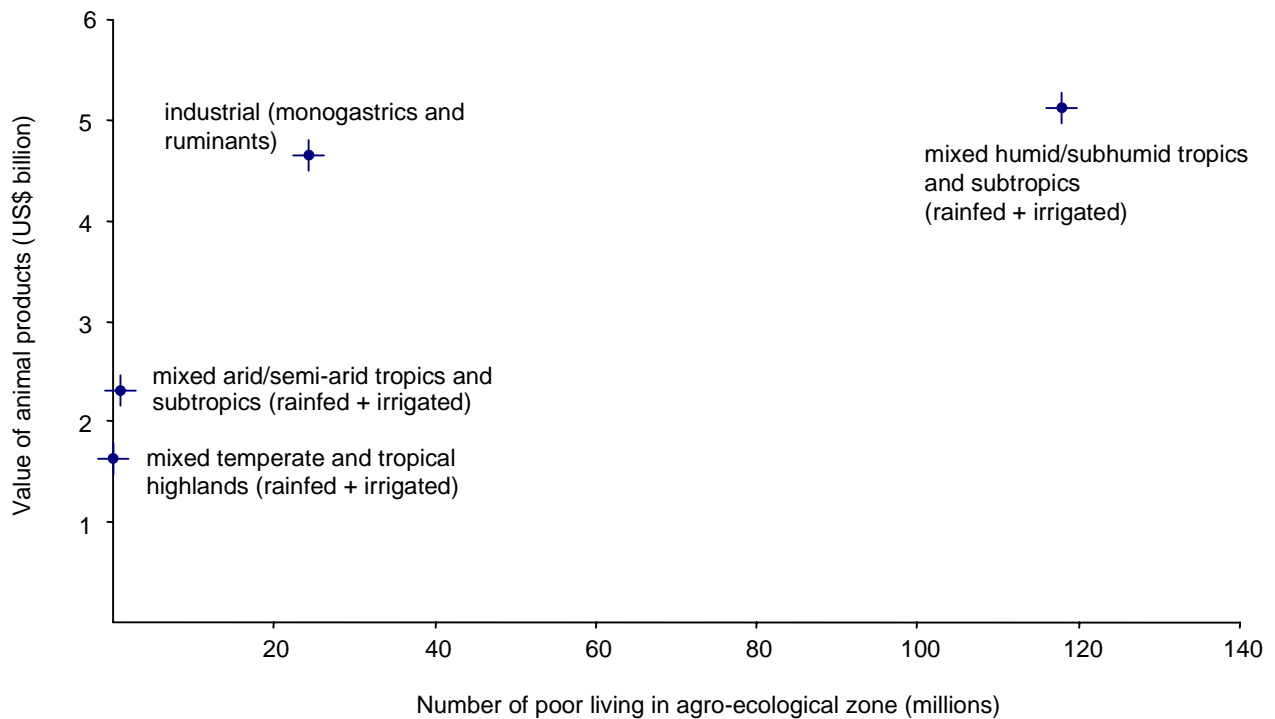


Figure 1.4 Value of animal production and extent of poverty in major livestock production systems in South-East Asia. (For sources, see caption for Figure 1.2.)

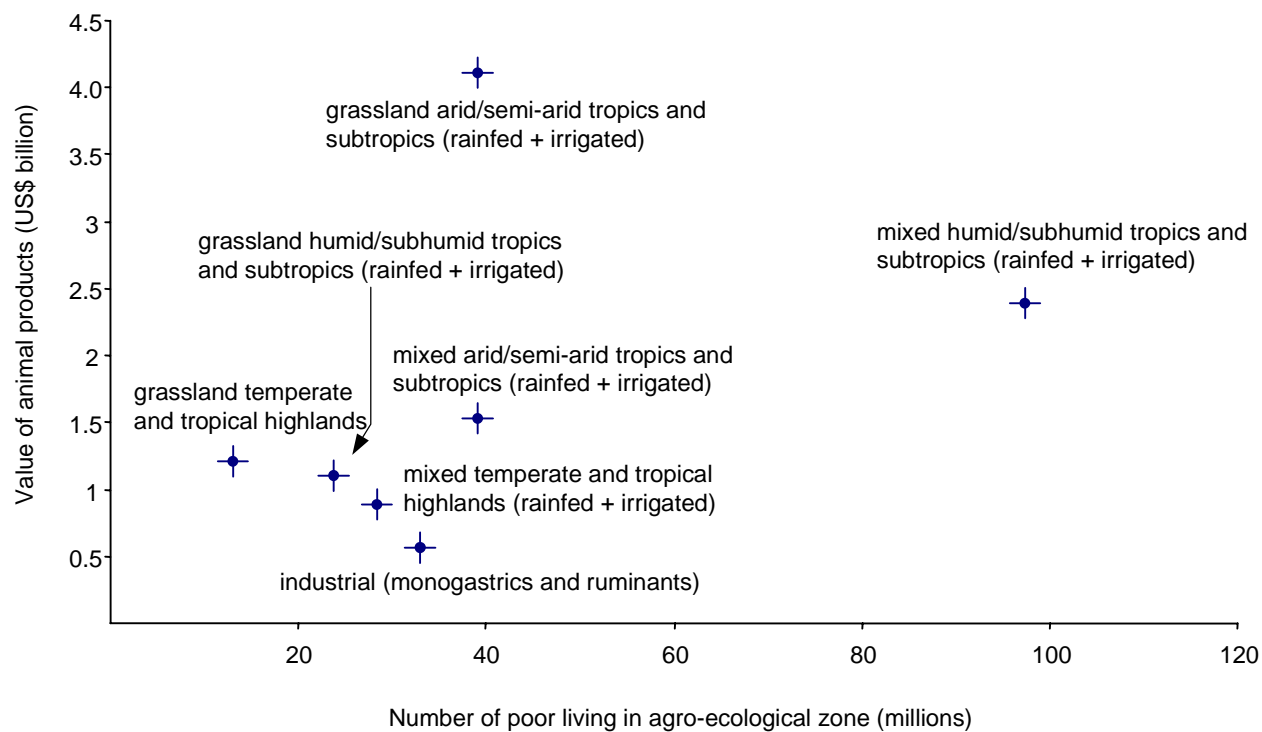


Figure 1.5 Value of animal production and extent of poverty in major livestock production systems in sub-Saharan Africa. (For sources, see caption for Figure 1.2.)

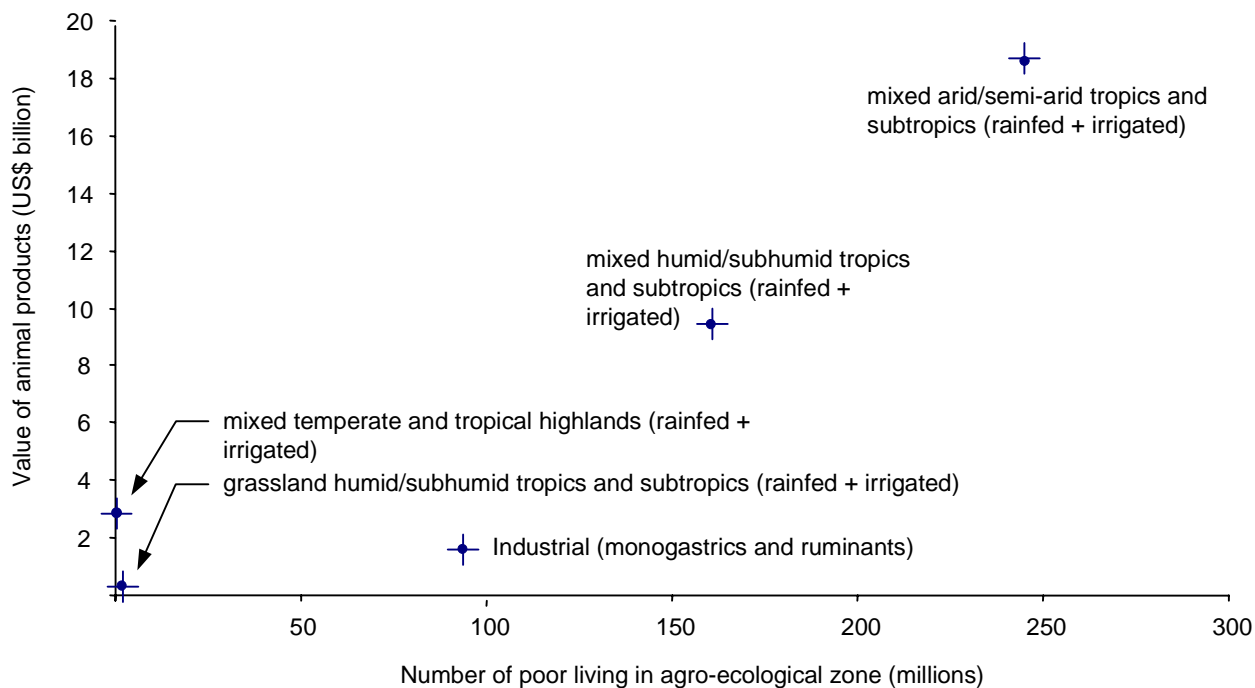


Figure 1.6 Value of animal production and extent of poverty in major livestock production systems in South Asia. (For sources, see caption for Figure 1.2.)

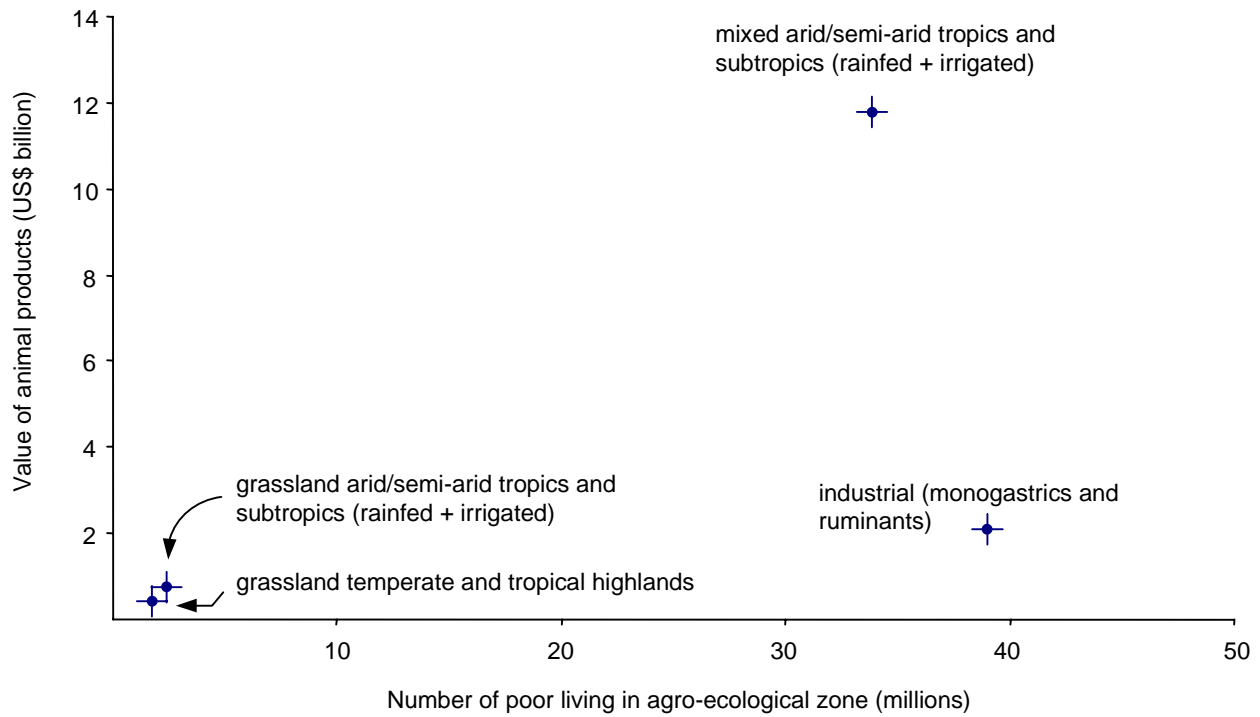


Figure 1.7 Value of animal production and extent of poverty in major livestock production systems in West Asia and North Africa. (For sources, see caption for Figure 1.2.)

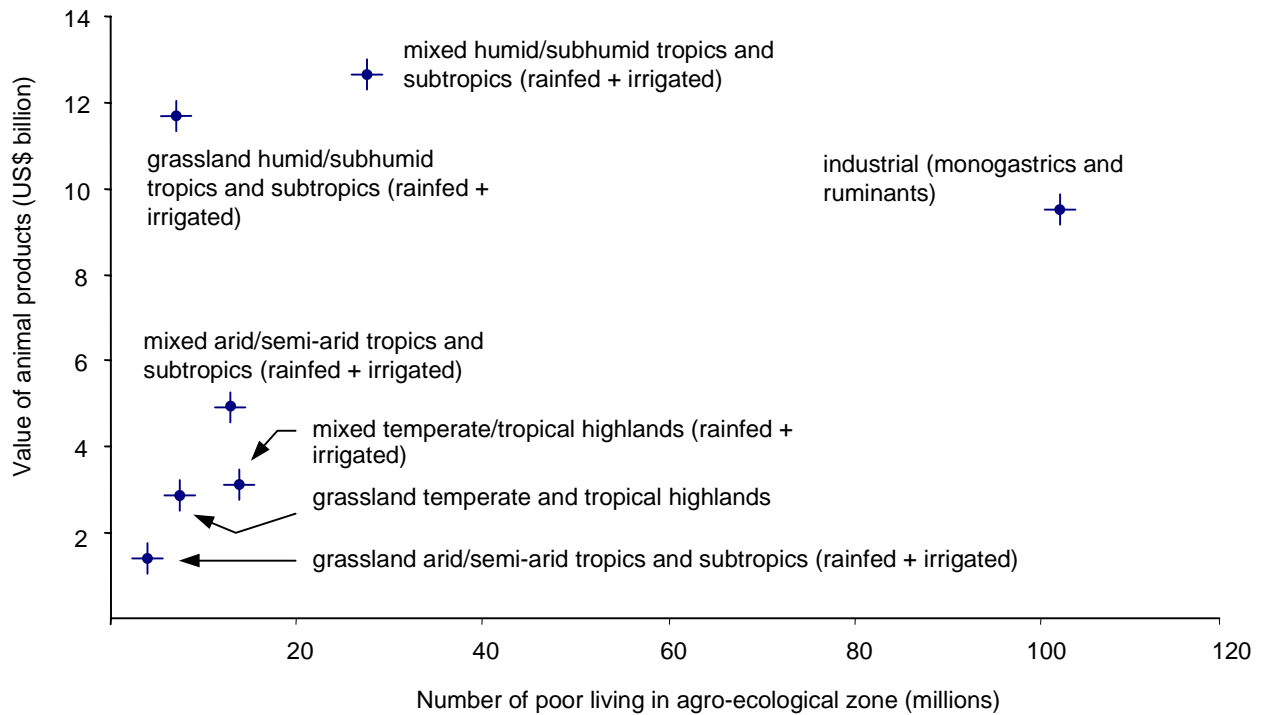


Figure 1.8 Value of animal production and extent of poverty in major livestock production systems in Latin America and the Caribbean. (For sources, see caption for Figure 1.2.)

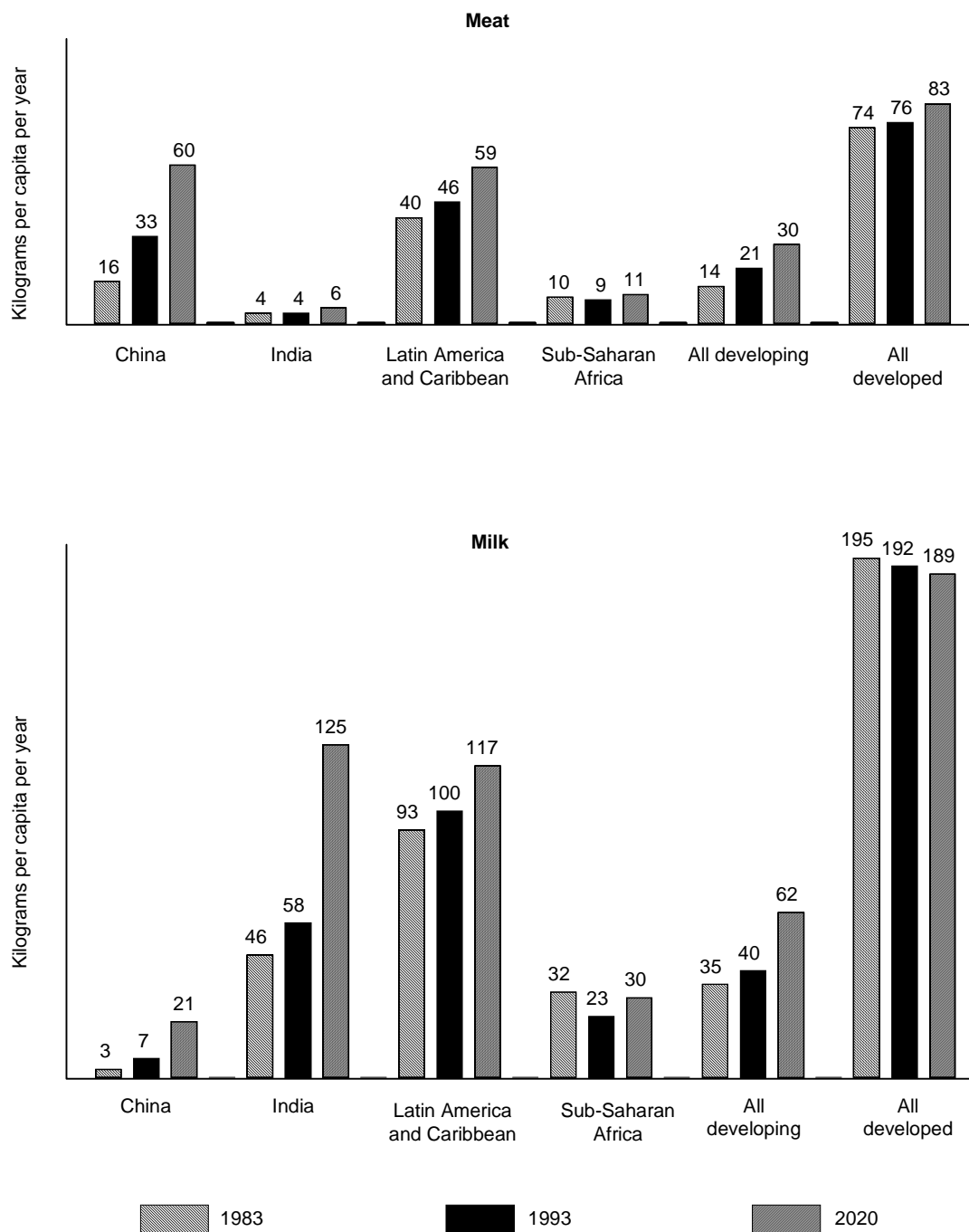


Figure 1.9 *Per capita consumption of meat and milk, 1983, 1993 and projected for 2020 (Delgado and others 1999).*

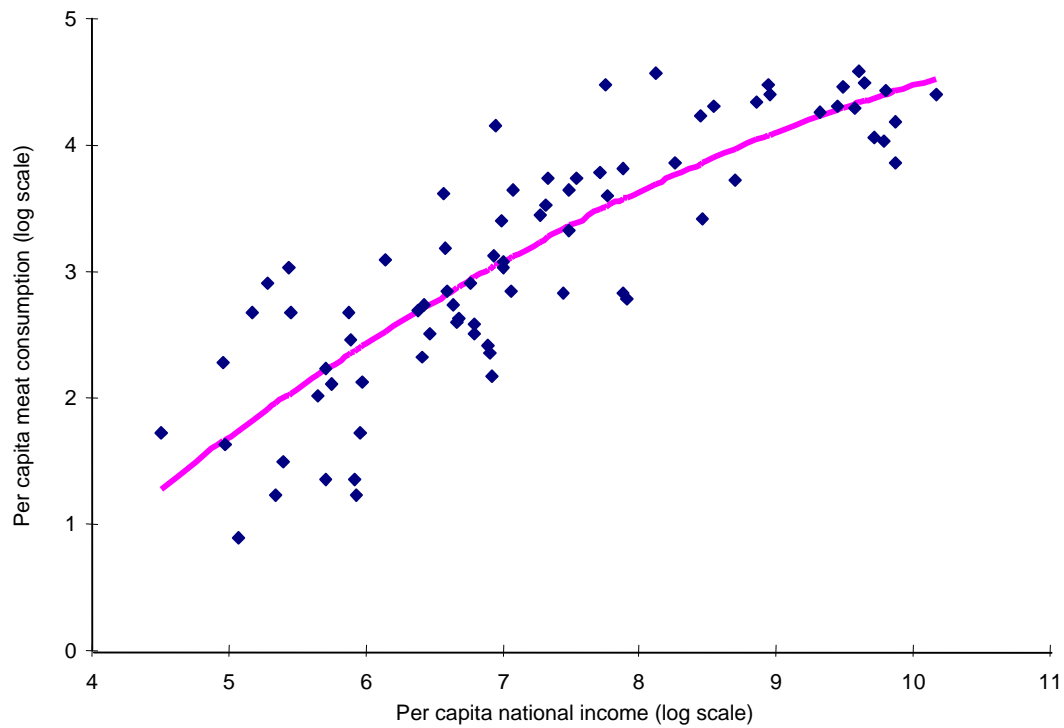


Figure 1.10 *The relationship between meat consumption and income (Delgado and others 1999).*

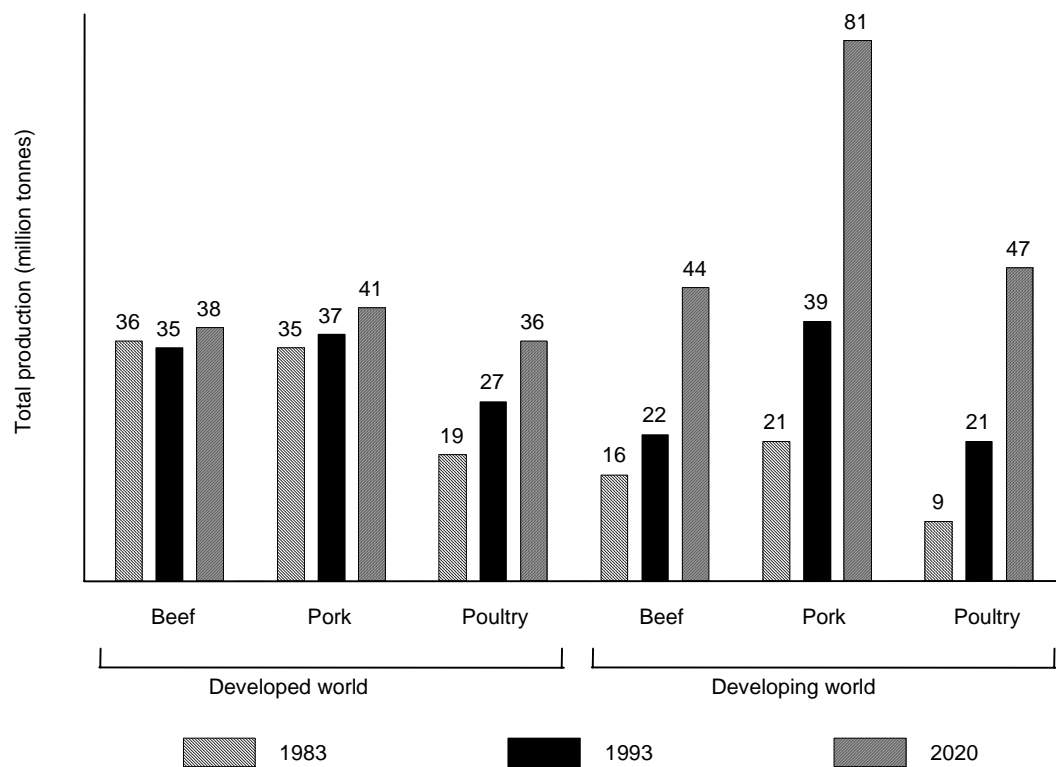


Figure 1.11 *Projected trends in production of various livestock products, 1983, 1993 and 2020 (Delgado and others 1999).*

2 Rationale for strategic choices

2.1 ILRI in the CGIAR

Being an international agricultural research centre supported by the CGIAR, ILRI is bound by its strategies, priorities, principles and values. ILRI also works towards realizing the goals of international conventions to which the CGIAR members are committed. This means that

- the success of ILRI's research must be measured by its impact on reducing poverty, improving food and nutritional security, and protecting the environment
- products from ILRI's research must be international public goods

Box 2.1

Major strategic issues from the ILRI External Programme and Management Review

The recent External Programme and Management Review of ILRI highlighted a number of strategic issues that have been explicitly addressed in developing the 'ILRI Strategy to 2010'. Points being considered:

- ILRI is best placed to emphasize strategic research dimensions, supplying products, methodologies and technologies in biotechnology and genomics applied to livestock and their diseases, and to prepare for the genomics era in livestock research. Research in animal nutrition is the second element of this international agenda to underpin biophysically enhanced livestock production.
- ILRI is well positioned to address the improvement of tropical animal health and production in an integrated manner. ILRI will focus—on the biological side—on genetic, diagnostic, epidemiological and nutritional technologies and resources, and—on the production systems side—on carefully selected animal production systems that are dynamic and market oriented, such as dairy systems. These research efforts need to be complemented by research on livestock policy and by systems and impact analyses.
- ILRI is urged to relate its research on production systems and natural resource management more closely to livestock market opportunities.
- It is in strategic, upstream research that ILRI will continue to have its comparative advantage. Therefore, the institute is strongly encouraged to continue these strategic areas of its programme.

Opportunities for building strength:

- Enormous promise in research on disease resistance and tolerance, and on genetic mapping
- Significant promise in immunology and molecular biology to exploit the fruits of genomics research
- Powerful options for the use of epidemiology
- ILRI's key role in generating, through its NARS links, the necessary data for enhanced efforts to conserve the genetic resources of domestic animals

In addition in 1998, the Third System Review of the CGIAR (1998) recommended areas in which CGIAR centres should focus their efforts. These include

- integrated gene management
- integrated natural resource management
- policy research
- strengthening capacity for agricultural research
- special initiatives for sub-Saharan Africa

More recently, the External Programme and Management Review of ILRI, commissioned by TAC and the CGIAR (TAC 1999), made key strategic recommendations that have been considered in formulating the ILRI strategy (see Box 2.1).

ILRI will be responsive to the changes in the priorities, strategies and policies agreed by the CGIAR. However, ILRI will also be proactive in providing research-based information and options for change in the CGIAR, particularly changes that have a direct bearing on international livestock research.

Issues and implications

Improved priority setting for research: *Methods, techniques and data for environmental and economic impact assessment for development-oriented research on livestock are needed to improve priority setting, resource allocation and research design.*

CGIAR strategies and priorities: *CGIAR emphasis is on poverty reduction, food security, environmental protection, international public goods, measurable impact, capacity building of NARS, scientific leadership and partnerships. ILRI should use these criteria in its strategic planning and priority assessment.*

Special needs of sub-Saharan Africa: *The CGIAR has identified sub-Saharan Africa as a region requiring special attention. ILRI also recognizes the particular needs of this region.*

2.2 CGIAR priorities and strategies for livestock research

A number of the goals, strategies and priorities of the CGIAR have a particular bearing on livestock research. These goals include progress towards equity, improved diets, nutrition and family welfare through better understanding of the links between production and consumption; improved post-harvest technology, which will make possible better use of livestock products; and better integration of livestock into sustainable agricultural systems.

As the CGIAR centre with a global mandate for livestock research, ILRI has numerous opportunities to apply its research to meeting the challenge of more food for more people while sustaining the natural resource base. In setting its priorities and strategies for livestock research, the CGIAR stated that an integrated holistic approach was needed, combining improved productivity with disease management to tackle complex problems (TAC/CGIAR 1993). Future livestock research would carry a mix of global and ecoregional programmes, linked in their focus and intent. A proportion of one-third research on animal health to two-thirds on animal production was deemed appropriate, with the work on both closely integrated.

Although the CGIAR felt that its major livestock focus would be on meat, milk and traction, and especially on improving ruminants, increasingly, consideration would be given to poultry and swine production. In sub-Saharan Africa, high priority would be given to integrated crop–livestock research in the subhumid tropics and the highlands. But overall, the focus would turn to more global and

broadly based ecoregional programmes, with new emphasis on the needs of Latin America and the Caribbean and of Asia.

2.3 Identification of priorities

ILRI's strategic planning process is detailed in Figure 2.1. The first level at which ILRI made its strategic choices involved its set of *necessary conditions*, which were applied to delineate issues and define key research and related areas (Table 2.1). This second level involved an array of *sufficient conditions* that enabled the identified issues and outputs to be addressed as priority research and related themes (see Section 2.7). If issues and themes did not first satisfy the necessary conditions, they did not receive further consideration as priorities for ILRI.

The *necessary conditions* for themes to proceed to the second level, as described in Figure 2.2, are that

- themes be researchable or feasible
- there was a clear potential impact on poverty if the research was successful
- ILRI had or could develop a comparative or complementary advantage vis-à-vis alternative suppliers
- outputs would represent an international public good
- ILRI had a well-defined role to play

Figures 2.1 and 2.2 – ILRI strategic planning and priority assessment processes

Out of this process a total of six *key research areas* and one *related area* emerged as priority areas to merit the attention of ILRI in the years to 2010. For each key research and related area a *strategic approach or approaches* to the solution of the respective problems were identified—13 in all. These approaches provide the broad boundaries within which the research portfolio of ILRI will be determined in the context of the medium-term plans (see also Table 2.1 and the appendix). These key research and related areas, which are described in detail in Chapter 3, are

- systems analysis and impact assessment
- livestock feeds and nutrition
- livestock health improvement
- livestock genetics and genomics
- livestock policy
- livestock and the environment
- capacity strengthening for livestock research

The relative emphases on these seven key research and related areas and strategic approaches will change during the course of the years to 2010 in response to emergent issues, imperatives and opportunities. However, Table 2.1 arrays the overall scaffold from which the precise themes of work will be built. The key research and related areas and their associated approaches represent a matching set, which allows exploitation of scientific synergies essential to ILRI's systems approach to international livestock research. As a result of this balance, the overall impact will be greater than the sum of the parts.

2.4 Regional research priorities from consultations

Since 1995, ILRI has convened and contributed to regional consultations and assessments of the priorities for development-oriented livestock research for

Latin America; South-East Asia (including South China); South Asia; Central Asia, West Asia and North Africa; and sub-Saharan Africa (Devendra and others 1997, 1998, in press; Devendra and Gardiner 1995a, b; Gardiner and Devendra 1995; Vercoe and others 1997).

The summary of priorities indicates the consistent importance of topics across regions, as shown in Table 2.2. In addition to these research priorities, NARS have expressed strong needs for livestock-related training and information services.

Because there had been limited international attention to livestock in Asia, more detailed assessments were undertaken for South and South-East Asia, followed by a research planning workshop in Hanoi. Conclusions from these detailed assessments:

- Seasonal variation in the quality and quantity of feed supply is the major constraint to improving productivity
- Increases in livestock production in South Asia will come from mixed crop–livestock systems in both rainfed and irrigated areas

Recommendations indicate the following research priorities:

- Evaluate indigenous and novel feed resources and their integration into the farming system
- Identify key areas where animal health measures will have the most impact
- Identify and use resistant genotypes in livestock breeding programmes
- Develop preventive and control measures for epidemic diseases
- Evaluate sustainability and environmental impact of recommended measures

Issues and implications

To compete effectively with industrial systems, resource-poor livestock keepers require improved feed and feeding technologies, especially to remove seasonal constraints.

Disease control technologies and management are required to improve the productivity of smallholder intensive and extensive systems of production and the competitiveness of developing countries in international trade in livestock and livestock products.

The importance of mixed crop–livestock systems and monogastric species in Asia implies the need to focus on these if the Asian poor are to benefit from the Livestock Revolution.

The genetic capacity of livestock breeds raised under the challenge of disease and parasites must be identified and pragmatic techniques developed to introduce these characteristics into breeds with desired productivity traits, thus developing livestock systems that are both sustainable and highly productive.

Table 2.1 Specific needs and opportunities arising from external influences and how the key research and related areas relate to them (this table considers the issues laid out in Chapter 1 and correlates with the details given in Section 3.5)

Specific needs and opportunities arising from external influences	Integrative research area	Intervention-generating research areas					
	Systems analysis and impact assessment	Livestock feeds and nutrition	Livestock health improvement	Livestock genetics and genomics	Livestock policy	Livestock and the environment	Capacity strengthening for livestock research
Rapid demand growth for pigs and poultry	✓	—	—	—	✓	✓	✓
Increased trade in livestock and livestock products	✓	—	✓	—	✓	—	✓
Need to exploit livestock genetic diversity	✓	✓	✓	✓	—	✓	✓
Response to demand–productivity growth gaps	✓	✓	✓	✓	✓	✓	✓
Enabling adoption and technology exchange	✓	—	—	—	✓	—	✓
Need for adequate livestock nutrition	✓	✓	—	—	—	✓	✓
Need for adequate disease control	✓	—	✓	✓	—	X	✓
Importance of mixed crop–livestock systems and monogastric species in Asia	✓	✓	✓	✓	✓	✓	✓
Need for integrated management of livestock health and genetics	✓	—	✓	✓	—	—	✓
Needs of pastoral systems	✓	—	—	—	✓	X	✓
Competition or integration of smallholder and industrial systems	✓	—	—	—	X	✓	—
Effects on the poor and the environment of increased demands for feed grains from the Livestock Revolution	✓	✓	—	—	X	X	—
Need for productivity-enhancing technology options in mixed crop–livestock systems	✓	✓	✓	✓	✓	✓	✓
Need for natural resource management and policy options for pastoral systems	✓	—	—	—	✓	✓	✓
Need to study evolution of livestock production systems to identify future needs and priorities	✓	—	—	—	—	✓	—
Study of animal-source food prices needed to monitor impact of livestock R&D on poor	✓	—	—	—	✓	—	—

	Integrative research area	Intervention-generating research areas					
Specific needs and opportunities arising from external influences	Systems analysis and impact assessment	Livestock feeds and nutrition	Livestock health improvement	Livestock genetics and genomics	Livestock policy	Livestock and the environment	Capacity strengthening for livestock research
Benefits the poor can derive from non-food uses of livestock	🦅	—	—	—	—	🦅	—
Need for methodologies and information on the impact of livestock on the environment	🦅	—	—	—	—	🦅	🦅
Better integration of crop and livestock production to exploit synergies to improve whole-farm productivity	🦅	🦅	🦅	🦅	🦅	🦅	🦅
Technology and policy options to address environmental and human health issues, especially in industrial and peri-urban livestock systems	🦅	—	🦅	—	🦅	🦅	🦅
Value of plant and animal biodiversity	🦅	🦅	—	🦅	—	🦅	🦅
Need for study of wildlife–livestock interactions to exploit species and system synergies	🦅	—	—	—	—	🦅	🦅
Necessity of factoring new trends in science into ILRI’s agenda	🦅	🦅	🦅	🦅	🦅	🦅	🦅
Improved access of NARS to new science, facilitated by ILRI	🦅	🦅	🦅	🦅	🦅	🦅	🦅
Methods, data and analyses to enhance priority setting in livestock R&D	🦅	—	🦅	—	—	—	🦅
Capacity strengthening and building for NARS	🦅	🦅	🦅	🦅	🦅	🦅	🦅

See also the issues and implications presented in the appendix. This table lists those that have significance for international livestock research and indicates the research and related areas where each has particular relevance. The issues are those judged to be researchable, to have relevance to the poor, to fall within ILRI's current or potential comparative or complementary advantage where it can play a suitable role, and to be international public goods.

Table 2.2 Research priorities identified from international and regional consultations

Research area	SE Asia	S Asia	LAC	WANA	SSA
Productivity and sustainability of crop–livestock systems	✓ ^{a,b}	✓ ^b	✓	✓	✓
Feed utilization	✓	✓	✓	✓	✓
Livestock biodiversity	✓	✓	✓	✓	✓
Natural resource management	✓	✓	✓	✓	✓
Livestock policy analysis	✓	✓	✓	✓	✓
Systems analysis and methodologies	✓	✓	✓	✓	✓
Plantation–tree–livestock systems	✓	✓	✓	—	—
Animal breed improvement	✓ ^c	✓	—	—	✓
Genetics of disease resistance	✓	—	—	✓	✓
Animal health, diagnostics, epidemiology, integrated control	✓	—	—	✓	✓
Forage biodiversity	—	—	✓	✓	✓

LAC – Latin American and the Caribbean; WANA – West Asia and North Africa; SSA – sub-Saharan Africa

a – uplands; b – lowlands; c – buffalo

2.5 Economic importance of livestock systems in regions

Asia represents almost 60% of the total value of animal production in the developing world (Figure 2.3). Then follows the Latin America and Caribbean region with just over 25%, West Asia and North Africa with 8%, and sub-Saharan Africa with around 7%.

ca0i eE=OKP-bAÇaÇãA-ão-aãéçêi-âf-aiÊeîÇAa=eoêiEãe-aa=ÇÊiÊaÇeaa0-AÇi âiêaÊe

For developing countries as a whole, the annual economic value of production of milk, pork, poultry and eggs, and beef and veal is approximately the same, at around US\$40 billion each. Mutton has a value only 12% of this amount. However, as with poultry, small ruminants have a special worth for resource-poor livestock keepers in view of their low capital value per head and short generation intervals.

In Asia, as shown in Figure 2.3, the most significant systems for livestock are mixed crop–livestock systems, both irrigated and rainfed, and the industrial system.

The economically dominant livestock production systems in the three subregions of Asia—all tropical and subtropical—are quite different. In South Asia the rainfed and irrigated arid and semi-arid systems are by far the most economically significant. In East Asia and South-East Asia, the mixed humid and subhumid systems—both rainfed and irrigated—and the industrial system are the most important.

The most economically important livestock product in Asia is pork, which has twice the value of the next most important product, milk. Pigs are predominantly an East and South-East Asian product. Poultry and eggs are almost as valuable as milk in Asia, with beef and veal representing about half the value of each of these.

In the humid and subhumid tropics and subtropics of Latin America and the Caribbean, the economic value of the rainfed mixed system and the grassland system is almost equal. Next in value is the industrial system, then the grassland

system in the temperate and tropical highlands. Beef and veal are the most valuable animal products in the region, with double the value either of poultry and eggs or of milk. Pork is only 20% of the value of beef and veal.

In the tropics and subtropics of sub-Saharan Africa, the system in the arid and semi-arid grasslands is the most economically important. Next are the mixed rainfed systems—first in the humid and subhumid lands and then in the arid and semi-arid lands. The two grassland systems, in the temperate and tropical highlands and in the humid and subhumid tropics and subtropics, each are about 25% the value of the foremost grassland system. Beef, veal and milk represent the most valuable animal products in sub-Saharan Africa, ahead of sheep and goat meat and poultry and eggs, which are all of almost equal value.

In the arid and semi-arid tropics and subtropics of West Asia and North Africa, the mixed systems, both rainfed and irrigated, are by far the most economically important. Next are the industrial and the grassland systems. The most important contributors to the value of production in this region are milk, poultry and eggs, and sheep and goat meat. Beef and veal represent only half the value of milk.

Issues and implications

Major differences exist among the geographic regions in the economic value of animal products, in the relative importance of different species, and the relative importance of livestock systems. International R&D priorities must accommodate this heterogeneity by focusing on pervasive problems and constraints where there will be large spillovers from region to region.

2.6 The priority assessment framework

A priority assessment framework (Figure 2.1) set this strategy and will be used to make informed choices among themes or projects for the medium-term plans. Its purpose is to rank candidate research and related themes objectively and rationally. The ranking is done in a transparent, quantitative process, based on criteria that reflect the spirit of ILRI's vision. The framework is based on the mission and mandate and that address the strategies and priorities of the CGIAR, as described in Sections 2.1 and 2.2. Briefs for candidate themes provide the necessary information on which to base the priority assessment.

Five criteria are used:

1. Relative severity of poverty in the regions and the livestock production systems where the research or related activities are relevant and are expected to have economic impact. This is to be measured as the relative severity of poverty in the regions and the livestock production systems where the research or related activities are relevant and are expected to have economic impact. It is weighted by the numbers of poor in those systems. The higher this number, the greater the priority of the theme. This consideration is additional to the *necessary condition* that there clearly be potential impact on poverty, without specifying the likely extent of that impact, as is done here. This measure incorporates both the depth and the breadth of poverty.

2. Net economic value (benefit less cost) of the productivity gains expected if the research or related activity specified in the theme is successful. This is measured by the present net economic value (benefit less cost) of the productivity gains expected if the research or related activity specified in the theme is successful. It is conditioned by the probability of research success, research and adoption lags, and ceiling levels of adoption. When considered along with the extent of poverty, the estimated new

income streams generated as a result of the economic impact measure provide a proxy for the potential contribution to food security. The impact measure does not include the economic value of environmental and social benefits.

*PI=baîæçããĒĒâî-î-îãé-ĀīW*Based on the descriptions in the briefs that have been prepared for each theme, an index is created to distinguish between themes with positive environmental impact and those with negative or no impact.

*QI=fâîĒĒâ-îãçã-âîîóW*The extent to which the theme addresses problems that are pervasive across countries and regions is measured by an index that gives more importance to problems of international relevance, other things being equal. This is in addition to consideration of the international public good nature of the research outputs, which has been considered as a *necessary condition* earlier in the process.

*RF= `~é-Āâîó-Āî āāÇããŌI-êĒĒĒ-êĀŪ-îççãë--âÇ-êĒĒĒ-êĀŪ-ĒWāĀĒĒĒĒô-çî îéî îëW*From the research briefs, an index is created that distinguishes whether these outputs of a theme are primary, secondary or minor.

After each of the themes is evaluated and quantified against the five criteria, the information is assembled and assessed using two approaches. The first is a series of graphs to examine the potential trade-offs between pairs of criteria. For five criteria, this means creating 10 graphs. Decision-makers can visually identify which themes have clear priority using all five criteria and for which, choices will have to be made.

Because it is difficult to make effective use of the information displayed in 10 graphs, a complementary approach is also used. The measures obtained for each criterion are converted to a normalized value, between 0 and 100. Themes with the highest measures are assigned the value of 100; all others are expressed as a proportion of 100. The five criteria are then weighted to reflect their relative importance to ILRI's vision, mission and mandate. For example, the poverty reduction criterion is like to be weighted higher than, say, internationality. From these weighted values, an additive composite index is calculated that incorporates all five criteria. This allows the research themes to be placed in an ordinal ranking. Sensitivity analyses can then determine how changing the weightings affects the ranking. The sensitivity analyses demonstrate the robustness of the priority assessment process.

A legitimate concern is that the quantification processes involved in estimating the measures of the five criteria for each theme and the weightings on them represent subjective judgements. To assuage these concerns, instead of using point estimates for the variables that constitute the quantification of the criteria, probability distributions are employed to provide ranges for the estimates. This process results in grouping the research themes into clusters that are categorized as being of high, medium or low priority, rather than obtaining an ordinal ranking, which implies a degree of precision not yet feasible with the data available.

Once the research themes are separated into high-, medium- and low-priority groups, the cumulative notional resource requirements are displayed alongside the respective theme, thus establishing a clear link between priorities and resource allocations. In this manner, the opportunity costs of increased or reduced budgets are clearly depicted.

This conceptual approach meets the need for an objective, transparent process for setting priorities and allocating resources. In practice, the precision of the approach depends on the quality and availability of data on which probability estimates for the success of research and the impact assessments are based. In

particular, the data on poverty by system, agro-ecological zone and region are limited. In the near term, informed estimates must be used. Fortunately, there are major initiatives that are under way by the Technical Advisory Committee (TAC) of the CGIAR, FAO and others, including ILRI will in the years ahead significantly improve the information base for estimating impact of livestock research on poverty and the environment.

But even now, this approach represents a considerable advance on previous methods that ILRI used to assess priorities, and it meets the essential requirements of being both transparent and quantitative. As shown in Figure 2.1, it also provides an opportunity to refine priorities regularly by factoring into the process the outcomes of impact assessments as they become available. These adjustments in priorities will be reflected in the medium-term plans. Details of the framework, the processes involved in obtaining measures of the five criteria for each theme and the analytical results are provided in a companion monograph in the ILRI Impact Assessment Series.

2.7 Implications for ILRI's strategic choices

Review of the external environment highlights a range of important issues and implications for ILRI's strategic choices. Indeed, the success of the strategy will be determined by how well ILRI is positioned to respond to the wide range of demands from its stakeholders. The issues and implications arising from the analysis of the external influences are summarized in the appendix. Each is assessed from a number of perspectives that reflect the *āĖĖĖĖ-ēō-ĀçāÇāīāçāē* to be a candidate for international livestock research (see Section 2.3).

If the issue satisfies all five necessary conditions, it is a candidate for ILRI's research agenda (see appendix).

The foremost external influence is the projected strong increase in demand for animal products from developing countries over the next 20 years. The question is whether the increased demand predicted on economic grounds can be met by sufficient response in supply, with disproportionate benefits to the poor, without adverse environmental consequences. The issues for ILRI's strategy are thus how to ensure that the increase in demand

- will provide opportunities for resource-poor livestock keepers to participate
- will reduce rural and urban poverty
- will improve food and nutritional security
- will result in sustainable increases in productivity
- will occur without adverse environmental outcomes

As ILRI, working with partners, must concentrate the institute's resources on the most pervasive problems where the spillovers among regions, species and livestock production systems will be large, its strategic choices will depend on

- which livestock products will be demanded
- where the demand will come from
- where lie the greatest opportunities for reducing poverty

OKTIV Choices of systems and species

ILRI's strategy for the rangelands will focus on issues such as carbon sequestration, conservation of biodiversity, and livestock policies that have international implications.

To achieve its overarching goal of poverty reduction, ILRI will concentrate on problems facing the majority of resource-poor, mixed crop–livestock keepers, who are in the higher rainfall tropical and subtropical ecoregions. These systems must contend with the whole spectrum of issues that face improving livestock productivity, including health, nutrition, limited exploitation of genetic potentials, and policy, along with issues that are transregional in nature such as stratified production and trade, and natural resource management.

Although poor people in the mixed crop–livestock systems in the temperate and tropical highlands are many fewer in number than in other zones, almost all are livestock keepers who have few options. Environmental externalities, such as erosion from treeless mountainsides silting up river systems or causing flooding in the valleys, provide a compelling case for international public R&D.

Dairying has a comparative advantage in highland regions, even though it represents less than 10% of developing country milk production currently. The challenge is to ensure that the poor participate in the economic growth potential that dairying presents in the temperate and tropical highlands.

As improvements in smallholder crop husbandry eliminate the yield gaps in crop productivity, strategic choices will have to be made in allocating livestock research resources. The choice will be between increasing the productive potential of animals *per se* or increasing the productivity of total systems by exploiting livestock to increase overall returns. This choice will be particularly complex concerning industrial systems, which require research agendas in policy and in ecological and animal health. Their reliance on feed grains has particular relevance to poor consumers of the same grains.

Research on beef and poultry will be required to limit the widening of gaps between demand and productivity, especially in sub-Saharan Africa. But in Asia pigs and poultry will be more important, and this situation will require clear strategic choices, because ILRI has a well-developed capacity for ruminant research but little capacity at this time for monogastric research. The strategy has to indicate which priority constraints of monogastrics in Asia will warrant an increase in ILRI's capacity, and where it should rely on alternative research providers.

The most basic requirement for smallholders is effective access to input and output markets. ILRI's strategy must also involve choices about how to empower smallholders so that they can negotiate on an equitable basis with large units, to which they are increasingly likely to become suppliers of feeder animals.

OKTIO Charting the way forward

To enable ILRI to contribute most effectively to international livestock research, the strategy will ensure that it remains at the forefront of the accelerating advances in information technology, genomics and biotechnology. To do this ILRI must chart a way through the maze of issues related to public concerns about genetically modified organisms, intellectual property rights, biosafety and animal welfare. Its strategy must reassure investors that ILRI complies with international standards on these issues.

ILRI's strategy towards 2010 will have to take into account the requirements and contributions of a much wider range of stakeholders than in the past. Forces generated by trade liberalization under the World Trade Organization largely drive this. It is compounded by the imposition of international obligations related to transboundary common goods expressed in a wide range of international conventions and undertakings, including combating desertification, conserving biodiversity and trying to reach the goal of halving the number of malnourished people by 2025. The enormity of the challenges indicates that the strategy will depend on collaboration based on the comparative and complementary advantages of partners from national agricultural research systems in developed and developing countries, especially publicly funded advanced research institutes, and the private sector, to accomplish the agenda for international livestock research.

Ultimately the strategy will bear fruit only if it enables ILRI to meet the goals of its investors. Reducing poverty is the overriding goal at this time, although providing food and nutritional security and protecting the environment remain important. These are guideposts against which candidate research and related themes in the seven key areas will be measured as priorities are set. ILRI's production-to-consumption approach will serve to integrate the programmes, from the time they are planned until they are implemented. The key research and related areas have emerged out of analysing external influences and through the planning process involved in developing the strategy. The strategy acknowledges that the majority of ILRI's investors are development agencies, and to retain their interest, a continual stream of products needs to flow out, be adopted and demonstrate impact. This will happen by maintaining a pipeline of short-, medium- and long-term research and related projects.

see files fig. 2.1 – LAN, fig. 2.2 – LAN, fig. 2.3 – LAN for figures for this chapter; insert as pages 39–41

STRATEGY

MEDIUM-TERM PLAN

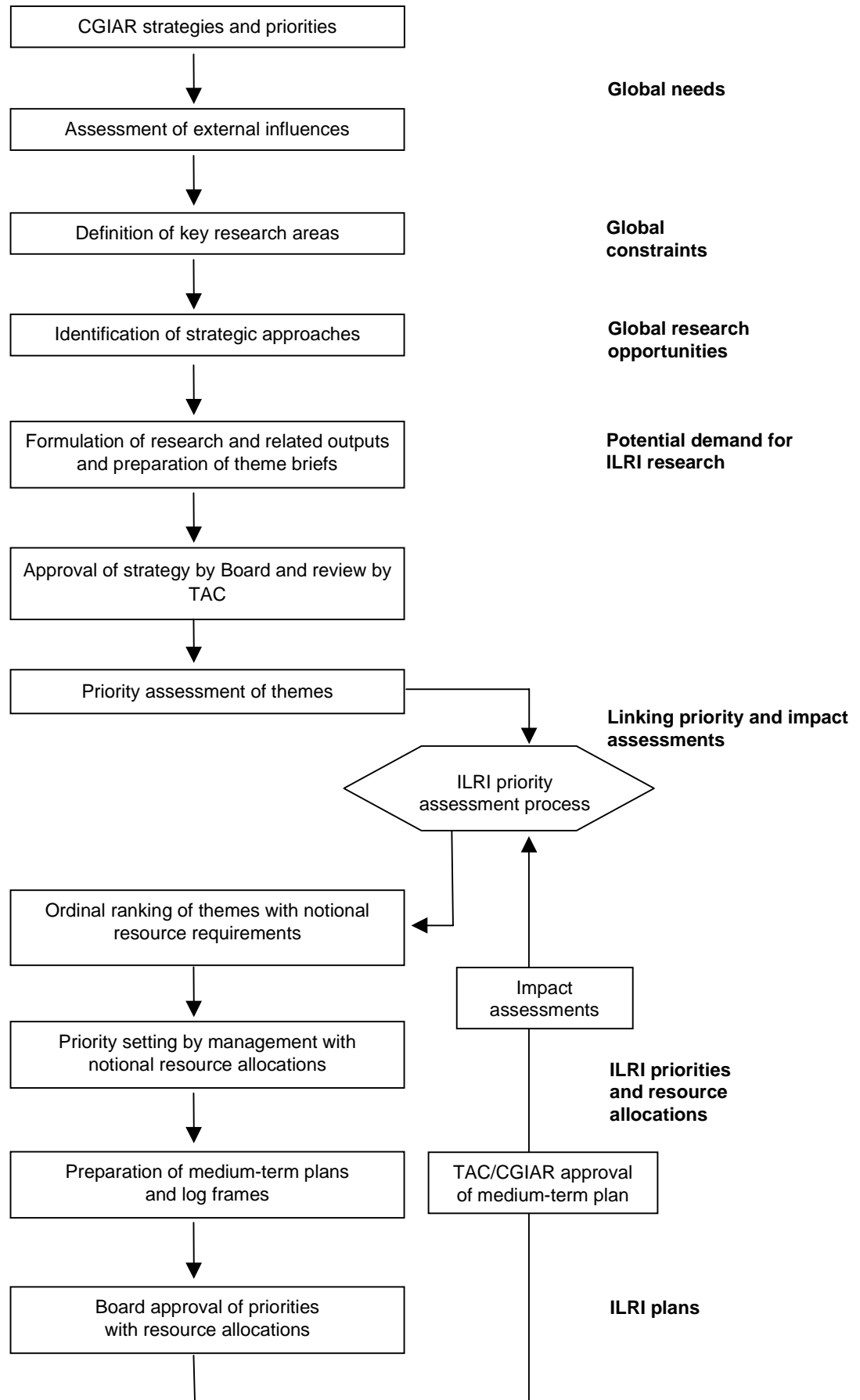


Figure 2.1 The ILRI strategic planning process. See Figure 2.2 for details of the priority assessment process.

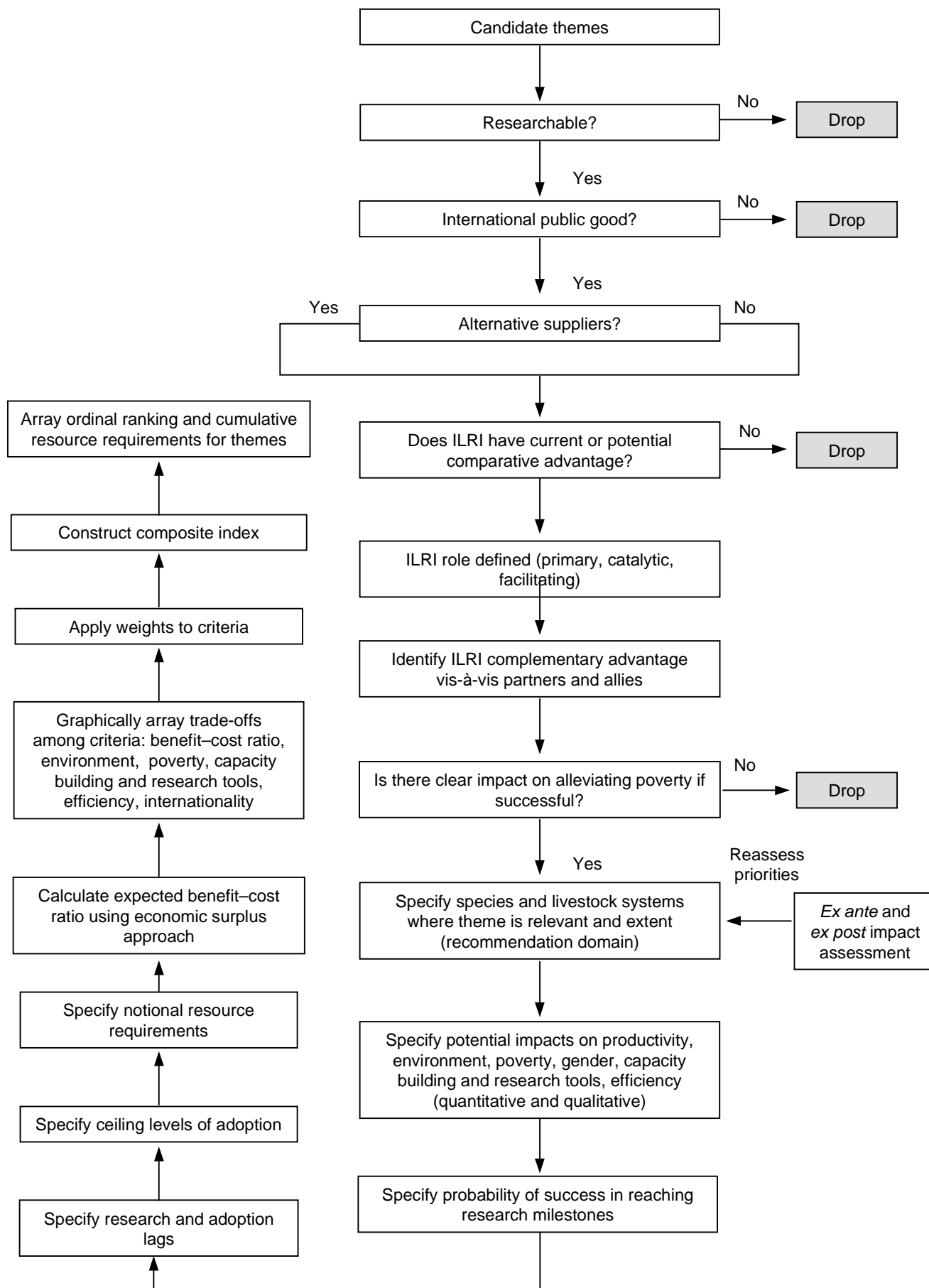


Figure 2.2 ILRI priority assessment process.

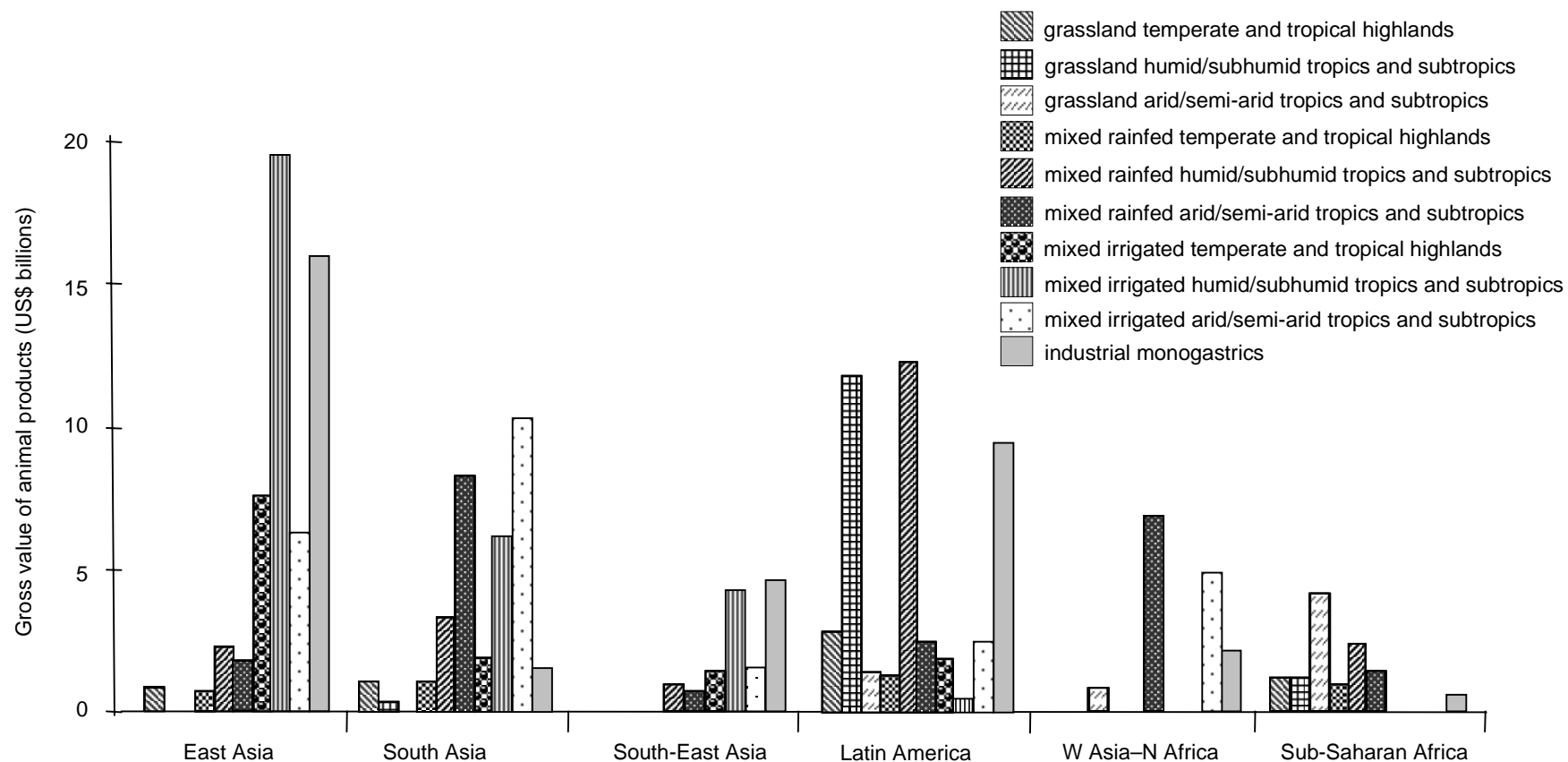


Figure 2.3 Economically important livestock systems in developing regions (includes beef and veal, buffalo meat, sheep and goat meat, total milk production, pork, poultry meat and eggs; values less than 1 billion are not shown). Sources: calculated from Seré and Steinfeld (1996) production data for 1991–93 using 1992–94 prices from Delgado and others (1999, table 28 p 35) except for eggs, which were valued at half the value of poultry meat per tonne.

3 Strategic choices

Analysis of the external influences on livestock research and development set out in Chapter 1 directs ILRI's strategy to 2010. Highlighted are a series of issues and implications (appendix), which fall into three broad categories: 1) researchable issues that are components of the agenda for global livestock research, 2) a subset of researchable issues that will receive priority within ILRI's criteria for beneficiaries, regions and species, and 3) issues and implications that will influence ILRI strategy implementing its programme.

This chapter indicates how these implications affect ILRI strategies and priorities. It details how they are taken into account to determine how, where, for whom and with whom ILRI should work to achieve maximum impact. They represent a first level of analysis, which focuses on the *necessary conditions* that must be met if the issues are to be included in ILRI's strategies and priorities. These conditions are the extent to which the issues are researchable, have relevance to the poor and the environment, fall within ILRI's current or potential comparative advantage, are international public goods, and have a suitable role for ILRI.

Analysis of the external influences has indicated which areas of livestock development are researchable and should receive priority. They form the agenda for global livestock research. Within these is the subset of what ILRI will do to make the Livestock Revolution work for the poor. The priorities for ILRI's strategic plan for regions, agro-ecologies, systems and species frame this subset. The interlinked set of seven key research and related areas that has been identified, as listed in Chapter 2, encompasses the broad range of areas essential for sustainable livestock development. They have the potential to produce public goods that will have a significant positive impact on poverty and the environment. They are areas in which ILRI specializes and has its main competence.

3.1 Where and for whom ILRI will work

ILRI's primary beneficiaries are resource-poor livestock keepers. They include the broad range of smallholder producers, from those endeavouring to subsist on the food and clothing that their livestock and crops produce, to the market-oriented smallholders whose resources are limited but whose production practices are geared towards selling their livestock products to bring them the income they need. One thing that sets the smallholder producers apart—regardless of whether their livestock are kept primarily on common grazing lands or on small farms—is that for-profit research does not serve their needs. Given that in developing countries, these smallholders, especially in Asia and sub-Saharan Africa, keep the largest numbers of livestock, for the foreseeable future they need the attention of ILRI and its partners who are publicly supported. The challenge is how to serve them so that they benefit from the opportunities that the Livestock Revolution will create.

In allocating its limited resources, ILRI has set regional priorities—geographical and agro-ecological—that take into account the recommendation domains to which ILRI's research will be directed, regardless of where the research is conducted. The locations where ILRI scientists are based will depend on where there is best access to the problems and to the partners, research

facilities and other resources that will increase the probability that research will be successful and have maximum spillovers to other regions.

3.1.1 Regional priorities

From the analysis of the external influences as presented in Chapter 1, it is clear that ILRI's research should be primarily targeted at sub-Saharan Africa and Asia (Table 3.1). In these regions are the greatest number of poor and the demand for animal products is growing most rapidly. Additional reasons for focusing on sub-Saharan Africa are that livestock research capability in the NARS is underfunded and needs strengthening, it has the largest potential demand–productivity growth gaps and the CGIAR accords the region special priority.

Table 3.1 External influences on regional priorities for ILRI strategy

External influences	Regions					
	E Asia	S Asia	SE Asia	LAC	WANA	SSA
Regional demand patterns	X	XX	X	—	—	XX
Economic importance of animal products in regions	XX	XX	X	XX	X	X
Regional distribution of the poor	—	XX	—	—	—	XX
CGIAR priorities and strategies	X	X	X	X	X	XX
Gaps between projected demand and recent productivity growth rates	—	—	X	—	—	XX
Need to strengthen NARS capacity for livestock research	—	—	—	—	—	XX

LAC – Latin America and the Caribbean; WANA – West Asia and North Africa; SSA – sub-Saharan Africa
Cells marked XX indicate the external influence is highly relevant in the region; X indicates the influence has significant relevance; cells with a dash (—) indicate only incidental relevance.

Because of its global mandate, ILRI will not neglect the regions of Latin America and the Caribbean, or of West Asia and North Africa, including Central Asia and the Caucasus, all of which have important livestock sectors with compelling and urgent research priorities. To respond to these demands, ILRI will identify opportunities and partners that complement and add value to research on topics of high priority for sub-Saharan Africa and Asia. Research in other regions will be funded through relevant national and regional sources. For example, in South Asia, as there are NARS with a strong capability for livestock research, ILRI's role will be mainly catalytic and facilitative.

3.1.2 Agro-ecosystem priorities

The majority of rural poor in developing countries are mixed crop–livestock farmers in the humid/subhumid and the arid/semi-arid tropics and subtropics (see Figure 1.2). These mixed systems will be the primary targets for ILRI's research. It will give secondary attention to systems in the mixed temperate and tropical highlands and the arid grasslands, and finally, limited attention to the temperate arid highlands, primarily in sub-Saharan Africa, and to the industrial systems. A transect approach will consider spillover effects from one agro-ecoregion to another, as they have strong social, economic and environmental interactions.

3.2 Which livestock production systems and species ILRI will address

Research on mixed crop–livestock systems should achieve the greatest impact on poverty reduction and food security and respond most strongly to NARS priorities (Table 3.2 and Figure 1.2). Due to expanding populations on fixed land areas, the need of smallholder crop–livestock farmers for options that will promote sustainable intensification is urgent. ILRI's research agenda will assess the links between evolving production systems, such as between smallholder and large-scale grazing and mixed systems in sub-Saharan Africa. It will look at the possibility of area-wide integration of specialized crop–livestock systems.

Table 3.2 External influences on system priorities for ILRI's strategy

External influences	Livestock production systems		
	Grassland	Crop–livestock	Industrial
Demand growth	—	X	XX
Economic importance of animal products in systems	—	XX	X
System distribution of the poor	—	XX	X
Making the Livestock Revolution work for the poor	—	XX	X
CGIAR special emphasis on sub-Saharan Africa	X	X	—
NARS priorities	X	XX	—
Livestock and the environment	XX	X	XX
Livestock and human health	—	—	X
Value of animal and plant biodiversity	X	X	—
ILRI emphasis on international public goods and its comparative advantage	X	X	—

Cells marked XX indicate the external influence is highly relevant in the system; X indicates the influence has significant relevance; cells with a dash (—) indicate only incidental relevance.

ILRI's partnerships will mean that broader research will be possible in production-to-consumption systems, particularly in dairying. The partnerships will involve the latest techniques in participatory research, market analysis, geographic information systems and other areas in which NARS want to collaborate. These partnerships will also make possible policy analysis and technology.

Environmental issues, biodiversity and related policy questions provide the major rationale for a focus on the grassland systems. ILRI has no comparative advantage to offer the industrial systems; its major contribution to them lies in research on environmental and related policy issues such as their impact on soil, groundwater and atmospheric pollution. Such issues will loom even larger in the future as these systems respond to the rapidly increasing demands for livestock products as a result of growth in incomes and urbanization.

The economic importance of species and the future demand growth suggest that cattle, buffalo, pigs and poultry assume priority over sheep and goats (Table 3.3). However, because of their lower value per head and shorter generation intervals, sheep, goats and also poultry have special relevance for the poor.

Table 3.3 External influences on species priorities for ILRI's strategy

External influence	Species				
	Cattle	Buffalo	Sheep and goats	Pigs	Poultry
Demand growth	XX	XX	X	XX	XX
Gaps between projected demand and recent productivity growth rates	XX	X	—	X	XX
NARS priorities	XX	X	X	XX	XX
Economic importance of species	XX	XX	X	XX	XX
Importance of species to resource-poor livestock keepers	X	X	XX	X	XX

Cells marked XX indicate the external influence is highly relevant for that species; X indicates the influence has significant relevance; cells with a dash (—) indicate only incidental relevance.

In sub-Saharan Africa, ILRI will focus on ruminants. The countries in this region can incur large opportunity costs to the rest of the economy if they import feed grains to support the intensive pig and poultry industries. Smallholders will continue to rely primarily on forages and crop residues for improved cattle, sheep and goat production.

As monogastrics in sub-Saharan Africa have an important role in food security and poverty reduction, their contribution to farm income and household nutrition will be assessed within the context of a small farm. Pigs and poultry will be increasingly important in Asia. But since technology for industrialized pig and poultry production is readily transferable from developed countries, ILRI will primarily focus on policy, environment and farming systems that are peculiar to developing countries and that have particular impact on the poor.

ILRI has ready access to tropically adapted forage and browse species, as Africa has the world's greatest diversity of wild and domesticated ruminants and their rumen microflora—an advantage when working to overcome ever-present feed constraints that exist in developing countries. ILRI is also well positioned to apply biotechnology and genomics to global livestock production and health problems.

3.3 How ILRI will work

Within the discovery-to-delivery-to-impact continuum, ILRI's most effective contributions will be through strategic research. Developed country providers are generally better financed and equipped to carry out more basic research, whereas developing country providers, because of their closer contacts with the end users, are usually better placed to handle the more applied and adaptive aspects.

The direct investments in ILRI's programmes are small compared with investments in national and other research institutions. For the CGIAR as a whole, the putative share is 4% of the total investment in national and international agricultural research. The proportions for international livestock research are probably lower, given the relative emphasis of the CGIAR on crop agriculture. Therefore, it is essential that through careful design of research, full advantage is gained from the links and synergies within ILRI and among its partners, as indicated in Figures 3.1 and 3.2, if maximum and measurable impact from investments in livestock research is to be realized.

Figures 3.1 and 3.2, Synergistic links and pathways

The goals, priorities and plans of the regional associations of NARS will heavily influence how ILRI will work. This will be particularly true in sub-Saharan Africa, where ILRI will be a principal contributor in the new strategy for the CGIAR in the region. The strategy is being developed with African NARS, subregional organizations, the Special Program for African Agricultural Research (SPAAR) and the Forum for Agricultural Research in Africa (FARA).

3.4 What ILRI will do

To address the seven key areas and 13 strategic approaches that ILRI has identified (see Section 2.3 and Table 2.1) calls for a systems approach to setting priorities, designing experiments, and delivering and evaluating research products.

Results from research will be evaluated in net impact on broader systems, considering interactions of the livestock component with other components. Interacting components of smallholder production systems include soil, water, crops, as well as livestock, wildlife and humans. Important livestock-related policy issues bear on how productive and sustainable the system will be. ILRI hence will follow a holistic systems approach to development-oriented livestock research.

This holistic approach implies broad research needs—beyond ILRI's capacity. Thus ILRI will rely on partnerships and alliances to optimize the use of resources. ILRI's appropriate roles in its seven key areas are addressed in Sections 3.5 and 4.2. Integrating them is

- systems analysis and impact assessment, which emphasize the importance of economic, social and environmental assessments as the basis for setting priorities and allocating resources

Generating interventions are

- livestock feeds and nutrition
- livestock health improvement
- livestock genetics and genomics
- livestock policy
- livestock and the environment

Strengthening capacity for livestock research threads through all six of these research areas, as it is essential if national partners are going to be able to deliver research to resource-poor livestock keepers.

Three of the research areas designed to generate interventions—feeds, health and genetics—directly address the livestock component; policy and the environment address livestock-related issues such as natural resource management in agricultural systems. There are significant synergistic links among these areas. For example, livestock health improvement will in future adopt an integrated approach to disease management rather than work to control individual diseases as in the past. This means integrating disease control with improved animal nutrition, genetics and other approaches that will improve animal health—on the farm and in the nation or region. ILRI's recognized comparative advantage in epidemiology and systems analysis will be essential ingredients in this approach.

In other links, shared facilities for biotechnology, genomics and bioinformatics directly contribute to ILRI's research in rumen ecology, genetics of disease resistance, identification of candidate antigens for vaccines, and characterization of genetic resources of indigenous animals and forages.

3.5 Key research areas and strategic approaches

3.5.1 Systems analysis and impact assessment

Strategic approach

- Develop databases, models and methods for analysing livestock systems to help identify priorities for research and interventions, integrate information, identify delivery pathways and assess impact

The problem

The role of livestock in rapidly evolving and complex agricultural systems is highly interactive with other agro-ecological, biotechnical and socio-economic elements of the system. The long production cycle for livestock, especially large ruminants, adds to the complexity of these interactions. The strategic decision to follow a systems approach, embracing the discovery-to-delivery-to-impact continuum, means that the consequences of research-based interventions must be measured in net impact. The databases, models and methodologies essential for assessing impact—including the *ex ante* assessments needed for priority setting—are poorly developed for livestock as compared with crop systems. In particular, methods for analysing the interaction of the livestock component with other components of a system are not well developed for smallholder systems in developing countries.

The opportunity

Significant advances in informatics, including GIS, and computing capabilities enable the development of models and methods that can address the complexities of the livestock component of agricultural systems. Improvements have been made in the databases required for livestock systems analysis, including livestock census, production statistics, disease incidence, price and trade data, and environmental factors. Systems models and analytical methods will contribute to the design of research into component and production systems and, in turn, will benefit from the additional primary data the research generates on the household, community, watershed and region.

Research outputs

- Criteria and minimum data requirements developed for characterizing livestock components for global agricultural systems
- Models and methodologies developed for assessing impact—economic, social and environmental
- Prediction of opportunities and requirements for improving livestock in evolving agricultural systems
- Identification of recommendation domains and delivery pathways for research-based interventions

Delivery pathways

The primary clients for the outputs will be policy-makers, planners and analysts in national and international agencies who are concerned with and responsible

for sectoral R&D investments involving livestock. Methodologies such as analytical models and decision-support tools will be conveyed to analysts and planners by publications, training modules and visiting fellow arrangements. Policy-makers will be exposed to the outputs by way of conferences, seminars and symposia, as well as policy briefs and other publications. Databases will be made available to collaborators and clients as required.

Links

Systems analysis and impact assessment research are closely linked with other research activities by drawing on primary data from them and applying models and methodologies, using impact assessment for priority setting, and developing decision-support models and data for informed policy-making.

Impact on the poor and the environment

The strategic research embodied in systems analysis and impact assessment will help ensure that research investments support the highest priority activities and that the results will alleviate the needs of resource-poor livestock keepers and consumers. This will help ensure larger economic and environmental impact in a shorter time.

3.5.2 Livestock feeds and nutrition

Strategic approaches

- Identify opportunities to improve the quantity and quality of the livestock feed supply
- Develop and evaluate ways to improve feed-use efficiency for meat and milk production

The problem

Quantity and quality of feed supply are generally the first limiting constraints to livestock productivity in developing countries. Undernutrition limits yield of meat and milk to a fraction of genetic potential and increases the animal's susceptibility to disease and parasites. Monogastrics are particularly sensitive to nutrient quality and balance, especially under intensive-confinement production systems. The significant increase in monogastric meat production projected in the Livestock Revolution will depend on balanced concentrate rations of starchy staples, proteins and essential micronutrients. These ingredients are essentially the same as those required by humans, so there is potential competition, especially for coarse grains, with poor consumers. For ruminants, major constraints arise from seasonal shortages and from poor digestibility of fibrous feeds including forages and crop residues. Many tropical plants have evolved phytochemical and structural protection against pests and predators, including wild and domesticated herbivores. These antinutritional factors include toxins and indigestible structural materials. Considerable research has been conducted in the tropics on feed supply and utilization. Still, smallholder adoption of the resultant technologies has been limited. Reasons have been lack of a holistic approach to link farmers' circumstances with alternative solutions, lack of a systematic research effort in seeking alternatives, and inadequate knowledge of the physiological response of animals to seasonal fluctuations in feed supply.

The opportunity

Advances in science and links with ecoregional research open the way for a more holistic approach to research on feed resources. A principal strategic research

opportunity is to characterize the nutrition of starchy staples, forages and protein sources that monogastrics may use, and tropical forages and crop residues that ruminants may use. Knowledge of the genetic basis for toxic and structural antinutritional phytochemicals can be used in plant breeding programmes. Knowledge of the physiological response by animals, including rumen microbes, to antinutritional factors can be used to develop interventions to detoxify and improve the digestibility of feeds, including tropical forages. These opportunities are manifested in the area of rumen ecology as it addresses the nutritional nexus of tropical plant–ruminant–rumen microbes. Characterizing the phytochemistry of indigenous tropical forages, trees and shrubs is also important in designing strategies for sustainable *in situ* conservation under natural grazing pressures.

A principal opportunity is to develop cost-effective rations from locally available, low-cost feed sources that will give the required levels of performance. The general principles underpinning development of appropriate rations draw on the well-established knowledge of the metabolic requirements of monogastric and ruminant livestock in temperate regions. However, under tropical conditions, in which livestock may be subjected to periods of severe feed scarcity or surplus within and between years, much less is known about the way animals adapt physiologically and how their performance reflects the way they compensate. An understanding of these processes will lead to better-designed feeding under field conditions. National research providers have a comparative advantage in the adaptive research problem of developing rations for specific locales.

Research outputs

- Genetic basis for the phytochemistry of tropical crops and forages determined
- Effects of phytochemical and structural factors on palatability and digestibility determined, as input to crop-breeding strategies
- Rumen ecology modified to improve feed utilization by detoxifying antinutritional factors
- Indigenous forage and fodder tree species, and food–feed crops characterized and evaluated for nutritional and antinutritional effects
- Low-cost strategic supplementation regimes developed to mitigate effects on livestock productivity of undernutrition and malnutrition
- Interacting effects of nutrition–disease–genotype on livestock productivity determined

Delivery pathways

Collaboration with international centres involved in crop and forage improvement will be used to ensure traits of value to livestock are built into their genetic improvement programmes. Collaboration with farming and production systems programmes of NARS, NGOs and farmer associations in priority regions will help ensure innovations that improve feed utilization are assessed in a holistic and participatory manner to enhance the prospects of adoption and impact.

Links

The nutritional status of livestock has a direct bearing on animals' resistance to disease and parasites and therefore is a key element addressed in

epidemiological research. Feed sources, including tropical forages, and their utilization are interlinked with research to improve systems productivity through nutrient cycling and integrated natural resource management. Use of feeding strategies is dependent upon the existence of markets for inputs and outputs, which is a key constraint addressed by policy research.

Impact on the poor and environment

Improving utilization of feed resources will reduce wastage and will increase meat and milk yields. The more cost-effective production will benefit producers and consumers alike. Using fodder banks and other agroforestry systems to supply leguminous forage and tree species for feed will improve soil fertility and increase the sustainability of mixed crop–livestock systems. By focusing specifically on low-quality, fibrous crop residues and fodders, the programme will be of specific relevance to resource-poor smallholder farmers in marginal areas, who do not have access to high-quality feed concentrates. This research will be especially important for the semi-arid and subhumid zones, as roughages in these zones are particularly high in fibre content. Improving the feed utilization of these low-quality fodders will also benefit the environment, as it will reduce the need for feeds with a cereal-grain base. As high fibre content is typically a tropical environment problem, the private sector is not interested in addressing it, because the market for the biotechnology is limited.

3.5.3 Livestock health improvement

Strategic approaches

- Improve livestock health by using quantitative epidemiology
- Develop and evaluate methods for disease prevention, therapy and control
- Assess economic impact of animal disease

The problem

Animal diseases are principal constraints to smallholder livestock production in the developing world. High incidence of disease can dramatically reduce productivity, and risk of disease restricts further investment and intensification in livestock production. Smallholder livestock keepers fail to effectively manage livestock disease—either because existing disease control technologies are not appropriately designed or are not made available, or because appropriate technologies have yet to be developed. To address these needs, research managers and development planners must have more accurate information on the extent of livestock diseases and their impact on the economy, poverty and the environment. Such information, which is currently lacking, is necessary for research to best target national and international disease control interventions and make optimal use of scarce funding resources.

Epidemic and endemic diseases continue to be a major constraint to livestock productivity in large parts of the developing world in the tropics. While many of the epidemic diseases have been controlled through the vaccines that are now available, they continue to cause severe economic losses through morbidity and mortality. These diseases include the infections caused by vector-borne haemoparasites and helminths. A number of existing technologies, such as chemotherapeutic agents and live vaccines that were previously successful in controlling these diseases, are no longer effective—because of acquired resistance or weakened delivery services. Appropriately designed alternatives are often

lacking. The situation is exacerbated by lack of interest in the developed world and the private sector to support research in diseases specific to the tropics. With the further globalization of livestock trade and trade regulations, many of these diseases will also increasingly block opportunities for developing countries to exploit their trade potential.

The opportunity

Advances in epidemiology and systems analysis are making it possible to better understand and describe the spatial and temporal distribution of animal diseases. This knowledge means that research efforts and control interventions devoted to both ruminant and non-ruminant livestock diseases can be rationalized, based on the important bearing these diseases have on tropical ecology and socio-economics.

Globally, this approach can be used to develop GIS-based information systems that integrate available information on the extent and impact of livestock diseases and, combined with other existing databases on ecological and socio-economic factors, to generate global disease databases. Such information systems will improve the setting of research priorities, in selecting species, diseases and production systems, and they will serve as the basis for economic analyses of the benefits of control interventions. The information systems will need to be further refined using improved epidemiological tools and models based on case studies in key production systems.

The need is particularly urgent to improve capacity of national governments to make decisions regarding cost-effective monitoring and control of the diseases that affect livestock trade, particularly in the context of the globalized regulation of world trade. Developing appropriate tools to help make and support these kinds of decisions will further the growing interaction between economic and epidemiological tools.

Existing methods, particularly chemotherapeutic agents and live vaccines, have been successfully used to control endemic diseases in defined farming systems. Immediate opportunities exist, with relatively small investment in research, to improve these agents and repackage them for effective delivery to smallholder livestock keepers. In addition, a number of new and exciting developments in the field of biotechnology are relevant to disease problems that as yet lack appropriate technologies. Exploiting the knowledge derived from microbial sequencing projects and linking it with bioinformatics will present opportunities to identify novel applications for drugs, and new diagnostic tools and vaccine candidates.

These approaches, in combination with improved knowledge of immunology and host-parasite interactions, will engender a more rational approach towards developing a number of new products that help control these diseases. In particular, the diagnostic tools will be used to generate epidemiological knowledge and evaluate the impact of interventions, while the vaccines will be used to artificially enhance population immunity. These products will be adapted based on information gained by concurrent research in disease epidemiology. Appropriate technologies and their delivery will be designed as components of integrated disease control.

Research outputs

- Global information systems on the extent and impact of livestock diseases on livestock productivity, food security and poverty, which will serve as the basis for economic evaluation of research and control priorities

- Decision-support systems to improve national policies and interventions with respect to diseases of intensification and trade
- New approaches and methodologies for collecting, analysing and synthesizing livestock disease information that will strengthen national capability in planning disease control
- Genome analysis and sequencing of pathogenic micro-organisms as a means of identifying candidate molecules as targets for new drugs, vaccines and diagnostics
- Robust subunit vaccines, which are highly efficacious, safe, cheap, easily deliverable and sustainable
- Appropriate diagnostic tools to underpin development and deployment of integrated disease control strategies

Delivery pathways

The primary clients for the outputs are national and international agencies responsible for veterinary policies, priorities and services in developing countries. Methodologies such as decision-support tools, databases and disease priority assessments will be conveyed to analysts and planners by publications, training modules and visiting fellow arrangements. Policy-makers will be exposed to the outputs by way of conferences, seminars and symposia, as well as policy briefs and other publications. The private sector, national veterinary services and NGOs will be the primary delivery pathways for drugs, vaccines and diagnostics. However, ILRI may have to be proactive in orchestrating novel intellectual property and public funding arrangements to position technologies for control of orphan animal diseases—the diseases in developing countries for which treatment may not be commercially viable. In this way, ILRI can help make it possible for the private sector to produce controls and smallholder livestock keepers to adopt them.

Links

These research efforts will lead to the development of animal disease control technologies and improved understanding of scientific relationships—including vaccine development, genetics of resistance, and nutrition–disease interactions—thus guiding priorities to ensure their relevance, while incorporating advances in diagnostics to improve epidemiological tools. The research will also build upon and reinforce similar activities in the area of systems analysis and impact assessment by using a common approach and integrating the epidemiological dimension. The global information systems and focus on diseases of trade will benefit and interact with the work on livestock policy.

Development of new technologies emanating from this area are linked with livestock genetics and genomics research and with human health research. Disease problems are closely tied to a number of other external factors; therefore, the deployment of integrated control strategies is linked with epidemiology, nutrition, production systems and policy research.

Impact on the poor and the environment

Integrated control of economically important diseases by using new and existing technologies such as vaccines will reduce morbidity and mortality and increase production and income of resource-poor livestock keepers. The reduced wastage of animals will have a major effect on overall food conversion efficiency, reducing pressure on scarce grazing lands and feed-grain supplies. This will

indirectly benefit the poor who consume the same food grains, relying on them as a staple food.

The focus of the programme on decision-support systems for national animal health policies, on vaccines that are robust, efficacious and safe yet cheap, and on diagnostic tools is especially relevant for the poor. Current national policies often give priority to clinical treatment and disease control of exotic animals, which are beyond the reach of the poor. Policy research, which can identify appropriate alternative delivery systems for the poor, will be key factor in reducing poverty. Similarly, the focus on thermostable vaccines and simple diagnostics is of direct importance for such alternative delivery systems, as it will provide safe disease control for the poor in remote and marginal areas, where veterinary infrastructure is often deficient. Finally, the focus on vaccines will reduce the current reliance on antibiotics and insecticides, and thus reduce the environmental and public health hazards of current chemical-based controls.

3.5.4 Livestock genetics and genomics

Strategic approaches

- Characterize indigenous animal genetic resources to improve their utilization and conservation
- Better utilize livestock biodiversity under various production conditions

The problem

Of the world's animal genetic resources (AnGR), which comprise some 40 species and 3800 breeds, one-third are at risk of extinction, and 60% of this third are in developing countries. The greatest diversity of AnGR is found in Asia and Africa, and these regions also contain the highest percentage of AnGR at risk of loss. By far the greatest cause of genetic erosion is the growing global trend for reliance on a handful of modern breeds best suited for the high input–output needs of industrial agriculture. This narrow selectivity results in reducing the biodiversity available for future production demands. It is largely unknown which breeds harbour significant genetic diversity and thus which need to be conserved. The problem is made more acute because there are no methods for valuing AnGR and thus make informed decisions about conservation. Breeds currently not making any significant economic contribution may be reservoirs of unique genes with substantial potential for use in unknown future environments. Furthermore, little information exists on production and adaptive qualities of most of the AnGR in developing countries. Consequently, breeds that could potentially make important contributions to sustainable livestock production continue to be underutilized and are increasingly at risk of being lost.

In general, indigenous livestock in the developing world yield less per head of milk, meat and other products than those in the developed world, where annual genetic gains of 1% or more of the breed average in milk production in dairy cattle and some 0.5% in growth to one year of age in beef cattle have been achieved over the last two decades through genetic improvement focused on a small number of breeds. Transplanting genetic improvement programmes from developed to developing countries, especially tropical regions, has often not been successful, and frequently, imported exotics have not reproduced or survived as well as locally adapted breeds. Negative correlations between productive traits (for example, milk yields) and adaptive ones (for example, tick resistance) highlight the importance of genetic characterization. The optimum genetic

improvement strategy will vary according to species, breed and production system. Progress will depend on availability of adapted indigenous AnGR. In addition to productivity, in many instances the strategy will have to consider adaptation and a wide range of functions performed by indigenous livestock in these production systems.

The opportunity

Animal genetic resources have evolved in diverse environments, largely through natural selection. These unique combinations of genes define not only productive qualities but also adaptive capability. They possess valuable traits such as disease resistance, adaptation to harsh environments and ability to use low-quality feed—all desirable qualities for achieving sustainable agriculture under low-input conditions. It is estimated that 50% of the biological diversity, in cattle, for example, is among breeds, and the rest within breeds. Rapid advances in molecular genetics make possible a better understanding of the nature of genetic diversity at the molecular level, enabling the widespread exploitation of useful genes in new breeds suited to future needs.

The Convention on Biological Diversity is a significant landmark among international agreements, and countries that have ratified it are committed to managing their biological resources, including livestock. A fundamental component of this management process is surveying and characterizing AnGR, with the objective of conserving and using these resources better.

Methodologies developed for economic valuation and quantitative and molecular genetic characterization of indigenous stock under normal production conditions will be generally applicable across regions and across systems that will include indigenous breeds of swine, poultry and camelids.

Although traits contributing to adaptation are generally much more difficult to measure and change than are production traits, genetic improvement using genomics as a tool makes it possible to introduce, for example, genes conferring disease resistance into highly productive but susceptible stock. Computer simulation and a murine model developed at ILRI will aid in applying such techniques as marker-assisted introgression to produce livestock that are productive and also better adapted. Alternatively, based on the relative importance of adaptation to harsh environments, a superior strategy may be to develop the production traits in breeds that are already adapted. Genes conferring disease resistance harboured in indigenous AnGR also provide the opportunity to study the regulation and expression of genes to evaluate them as potential targets for therapeutic intervention or vaccine development.

Methods to value AnGR and molecular tools to characterize indigenous breeds harbouring genetic diversity will make it possible to identify indigenous AnGR for which conservation and use strategies should be targeted.

Research outputs

- Genetic diversity in indigenous AnGR quantified as a basis for conservation and sustainable utilization
- Indigenous breeds characterized for fitness and production traits at phenotypic and genetic levels to facilitate their utilization
- Genes and quantitative trait loci for adaptation and production identified and characterized for application in genetic improvement programmes
- Breeding strategies developed to improve utilization of the diversity in indigenous livestock to increase productivity in smallholder systems

- Methods for assigning economic values (direct use and non-market) to AnGR (such as species, breeds, traits, genes) developed to better focus programmes for conserving and using AnGR

Delivery pathways

Genetic information and methodologies will be provided to NARS breeding programmes in publications and in seminars, conferences, symposia and training programmes to facilitate their use in livestock breeding programmes. Genes and quantitative trait loci for desirable traits will be made available to NARS and the private sector from nucleus herds and flocks using artificial insemination and other technologies.

Links

Links are in the areas of genomics research focused on vaccine development; integrated disease control; strengthening of knowledge and skills of NARS to develop and implement genetic improvement strategies; understanding of indigenous knowledge in relation to AnGR, to improve productivity and natural resource management of livestock production systems; use of feed resources to improve productivity.

Impact on the poor and the environment

Characterization and economic valuation will bring about cost-effective conservation of indigenous animal biodiversity, providing the basis for a wider selection of genetic material that can be exploited to adapt to changing production and market conditions for the benefit of smallholders.

The conservation of local AnGR will directly benefit resource-poor livestock keepers, for whom importing exotic breeds is not an option, because they cannot afford the inputs such imported genetics require, or the harsh environment they live in is suitable only for locally adapted breeds. Similarly, the introduction of disease-resistant characteristics will reduce the reliance on outside inputs, which would benefit the poor and the environment. Conserving domestic biodiversity is now considered critically important for sustaining future production systems. The strong shift towards industrial forms of livestock production has meant the use of only a limited number of homogenous livestock breeds, and thus it is causing a further erosion of domestic animal genetic resources. Identifying effective means of conserving this biodiversity therefore will be directly beneficial to resource-poor farmers and the environment, both now and in the future.

3.5.5 Livestock policy

Strategic approach

- Develop policy options that encourage and enable sustainable livestock development that benefits the poor

The problem

Too often policies and regulations actually discourage development of safe, sustainable livestock production systems and practices that benefit the poor. Subsidies and price controls imposed on input and output markets may favour large-scale or developed country producers over smallholders in developing countries and urban consumers over rural livestock producers. Inadequate or inappropriate property rights and environmental policies are disincentives that work against protecting the natural resource base supporting animal agriculture,

and they may fail to take adequate account of the societal costs of environmental degradation. Lack of policies and institutions that reduce risk, improve market access, provide credit, encourage private investment in livestock services (feeds, health, breeding) and support livestock research and extension deter sustainable livestock development.

The opportunity

The more coherent and transparent a livestock policy framework, the clearer will be the signals it sends to stakeholders, and the more effective and efficient will be decisions by these stakeholders in contributing to livestock development objectives. Livestock policy analysis—by building understanding of how alternative strategies towards the livestock sector development affect complementarities and trade-offs among the different social and economic development objectives—is crucial to such coherence and transparency. Rigorous policy analysis is particularly important in gaining purchase to key trends in livestock development, which is central to ILRI's research portfolio. Trends and developments to watch include

- the burgeoning global demand for milk and meat
- brisk changes in livestock production enterprises and land-use patterns, particularly in peri-urban areas
- the effect of vertical integration on market opportunities for smallholders
- credit policies in domestic capital markets that favour large-scale enterprises
- property rights regimes and their effect on natural resource management
- loss of plant and animal biodiversity
- private services replacing governmental provision of livestock health and other services and input-output markets in increasingly liberalized economies
- the growing importance of concerns about human health and nutrition as they have an impact on developing and delivering livestock technology
- the sluggish adoption of some productivity-enhancing technologies and the vigorous uptake of others
- the exhaustion and degradation of natural resources in some systems but their preservation and enhancement in others

Clear insights into the causes and consequences of these trends and developments will improve prospects for policies that encourage sustainable livestock development while benefiting the poor. ILRI's policy research will bring to bear economic, institutional, sociological and anthropological analysis of these issues. An important strength that ILRI has is the ability to incorporate in-house livestock expertise into policy analysis, thereby improving the technical relevance of policy outputs. Other opportunities supporting ILRI's contribution to livestock policy research include access to primary data from research in households and farms across regions, participation in ecoregional consortia addressing natural resource management and systems productivity, and close links with the International Food Policy Research Institute (IFPRI) and other international agencies noted for policy research.

Research outputs

- Databases on livestock, poverty and the environment developed from primary household and community level research, to be linked to those developed by the Systems Analysis and Impact Assessment group
- Identification of policy-related constraints on greater uptake and impact of improved technologies and opportunities to overcome them
- Policy options that assist smallholder livestock keepers to intensify production in economically viable and sustainable systems
- Alternative instruments for allocating access rights to common property, controlling use and mitigating risk, and their effects on smallholder livelihoods, their terms of trade and natural resource management
- Options for increasing efficiency of input and output markets serving smallholder livestock producers
- Land-use strategies, market mechanisms and policies for intensifying mixed-farming systems to promote area-wide integration of specialized livestock and cropping systems
- Improvement of productivity and sustainability of grazing-based systems through institutional and policy interventions

Delivery pathways

Policy-makers and their advisers and analysts in national governments and those in international development agencies will form the primary clientele for the research outputs. Policy briefs, other publications and consultations will inform policy-makers; conferences, seminars, symposia and training programmes will be used to relate to their advisers and policy analysts.

Links

Policy-related constraints on livestock development touch on all aspects of ILRI's integrated research programme. Policy research outputs thus will support a wide range of activities within the institute and will so assist in improving impact of ILRI's technology development activities. Similarly, expertise from other ILRI units will be brought into policy research as needed. As an international non-profit institute, ILRI is well placed to catalyse and support NARS policy analysts to conduct studies that cut across country borders on the effects of adopting alternative livestock-related policies.

Impact on the poor and the environment

Improved regional and global databases will make it easier to identify problems and analyse comparative policy options. Greater participation of stakeholders in policy research will shorten the period between discovery, delivery and dissemination. Comparative market analysis will support informed reform of these markets using best practices. New and targeted policy options will improve natural resource management.

Having information on livestock, poverty and the environment readily available will be a direct aid to national and international decision-makers as they allocate resources. Such information will also be critically important in empowering the poor in producer organizations and in enabling them to engage in policy dialogue with their governments. Of special importance for the poor will be the emphasis on technology delivery; because traditional forms of technology dissemination are not effective, new and innovative approaches are

necessary. Finally, the focus of this programme on the link between policy, livestock and environmental degradation will help to ensure that future production systems are sustainable.

3.5.6 *Livestock and the environment*

Strategic approaches

- Evaluate the effect of livestock management decisions on the environment
- Develop technical and managerial means to improve livestock-related natural resource management

The problem

Increased demand for livestock products will place increased pressure on the natural resources supporting livestock production. Population pressures, both human and livestock, will bring increased competition for land use. Such competition can lead to pollution, erosion, degradation and loss of plant and animal biodiversity, including wildlife. In the more extensive systems of grazing and mixed livestock, competition for resources affects the crop–livestock land-use choices of smallholders and increases pressure to convert forested lands to pasture and crops. Little is known about the causes and consequences of livestock-related problems for natural resource management in evolving systems. Trade-offs between increasing income and food security for poor people in the short term and conserving natural resources to serve longer-term needs are not well understood. This lack of knowledge hinders development of effective interventions and strategies to improve livestock-related natural resource management to increase productivity of mixed and grazing systems. Industrial and peri-urban systems generate pollution that adversely affects urban land and water resources, often to the particular detriment of the poor. Such systems also represent an increased risk of zoonotic diseases. Failure to cost these environmental and public health externalities may give large-scale producers unfair economic advantage over smallholders.

The opportunity

Integrated approaches to natural resource management will promote sustainable increases in productivity of livestock in agro-ecosystems. Livestock can enhance the natural resource base by improving soil quality, increasing the value of plant and animal biodiversity, and providing the draft power for shaping land to control soil erosion and protect water resources. Improving nutrient availability and utilization through balanced and efficient use of organic and inorganic nutrients is the key to sustainable mixed-farming systems. In local communities, livestock keepers need better and more appropriate technologies and management practices to conserve the natural resources. For example, crop residues, forages and supplements need to be better used to increase livestock productivity. Good-quality manure and better nutrient cycling will improve soil fertility and crop output. When livestock improve ecosystems, these management successes need to be applied to other ecosystems.

Better policies can promote environmental conservation and at the same time permit farmers to achieve their aspirations for short-term gains. Knowledge is needed to understand the connections between poverty, livestock and the environment—locally, regionally and globally. This will lead to the design of policies to make livestock productivity compatible with environmental enhancement. As urbanization increases and production systems intensify, the

negative effects of pollution and health hazards need to be removed by relocating industrial and intensive livestock production systems away from urban centres. The concept of area-wide integration of specialized crop and livestock systems to meet market demands and protect the environment thus becomes relevant.

Research outputs

- Local, regional and global models developed of the causes and consequences of poverty and natural resource degradation in livestock ecosystems
- Development of integrated crop–livestock management systems for improved nutrient cycling, including area-wide integration of specialized livestock and crop production
- Development of models for assessing feed balance, soil nutrient flows, erosion, water pollution and other effects of alternative livestock production systems at farm, watershed, regional and global scales
- Recommendation domains for research results identified, so successful integrated natural resource management interventions in one region can be applied to others

Delivery pathways

The primary clients for the outputs are policy-makers, advisers, planners and analysts in national governments and international agencies responsible for establishing environmental policies and regulations in regions and ecologies where livestock and wildlife are important. Policy briefs and other publications will provide vehicles to inform policy-makers; conferences, seminars, symposia and training programmes will be used to relate to advisers and analysts.

Links

Research on livestock-related integrated natural resource management will link closely to the research of other CGIAR centres and their partners in ecoregional consortia. Within ILRI, this research will link with research on feed resources, biodiversity, land-use and environmental policy, systems analysis and, especially, with field research on production-to-consumption systems.

Impact on the poor and the environment

The programme will focus on production systems and environments of particular relevance to the poor. By focusing on mixed systems, it will cater for the large majority of poor smallholders in the developing world. Effective management of nutrient flows will be of direct benefit to the poor and the environment, as it will reduce the dependence on inorganic inputs. The focus of natural resource management work on rainfed, often marginal environments is directly relevant to the poor. The combined technological and institutional focus of this programme ensures that critical issues of access to resources—one of the main causes of the poverty trap that holds millions of smallholders—will be addressed. The particular focus on area-wide integration with industrial production will identify how the environmental costs of large industrial units can be internalized, and thereby mitigate the crowding out of smallholders because of unfair competition from these large units.

3.5.7 Capacity strengthening for livestock research

Strategic approaches

- Provide interactive knowledge and information products and services to support livestock R&D
- Improve the capacity for livestock R&D by providing training and developing network links for technology exchange

The problem

The previous six key areas have all been in research. Capacity strengthening cuts across all and is essential to all. For without knowledge of the research results, without the ability to make use of them and disseminate them, the research itself will be of little benefit to the poor for whom they are intended. Capacity strengthening here is subdivided into two categories—gathering and disseminating information and building local and regional capacity.

Information. Ready access to relevant, systematic data, information and knowledge is a prerequisite for effective livestock R&D. It is essential that such a flow from ILRI's research be made readily available so that it can benefit resource-poor livestock keepers and achieve the intended impact. Currently many NARS lack ready access to information systems where they can both acquire the information they need and disseminate the products of their own research.

Capacity. Throughout much of the developing world, national institutions are unable to adequately address issues critical for livestock R&D. Much of this inability is due to the lack of skilled human resources and adequate financial resources. This problem will worsen over the coming 10 years as NARS address the huge increases in food production needed from livestock. To meet this demand, NARS will need skills to solve complex problems and to successfully use systems research and the new sciences. Whether many developing country universities have the ability to train enough researchers in these areas is a growing concern. Moreover, ILRI needs partners to effectively fulfil its research mandate, and the most important partners will continue to be NARS scientists and institutes.

The opportunity

Information. Recent and anticipated developments in information and communication technologies offer the possibility of quick, global dissemination of information in multiple forms. Information will play an increasingly important role in improving the links between livestock research, extension and technology transfer. Present trends indicate that in 10 years, most if not all developing countries, even in sub-Saharan Africa, will have access to these technologies.

ILRI is uniquely placed as a producer and provider of data, information and knowledge focused on livestock R&D in developing countries. It has a vast collection of information on livestock agriculture and access to information produced by its NARS partners. Traditionally, NARS researchers have been on the receiving side of the information exchange. Technological developments and their rapid adoption will make it possible for NARS, extension staff and increasingly for farmers to actively participate in global information exchange.

Communication technologies will allow ILRI's information services to have global relevance and impact through electronically mediated collaboration, thus enhancing interactions between scientists at distant sites. ILRI will expand its existing links with other important information brokers, such as FAO and CAB

International. Collaboration with FAO in particular will lead to a shared strategy for information systems for strengthened livestock R&D and for food security.

Capacity. Improved institutional capacity for livestock R&D will be achieved through training and facilitating links and networks. Training activities to which ILRI will contribute include degree-related research programmes; short courses and individually tailored programmes undertaken on behalf of, or in conjunction with, partners, including international organizations and universities; and the development of training resources. Advances in technology will allow ILRI to develop Web-based training resources that NARS and developing country universities can cost effectively use.

The third CGIAR System Review recommended the development of a demand-led African Capacity Building Initiative in sub-Saharan Africa. ILRI will contribute to the livestock and crop–livestock components of the initiative. It will retain a separate training function to build capacity for livestock R&D outside sub-Saharan Africa.

Networking will make it possible for NARS partners to jointly plan and set priorities, implement agreed collaborative research agendas, train and share information. By 2010 the subregional organizations in sub-Saharan Africa will have taken increasing responsibility for supporting and managing the livestock agriculture networks. While the role of ILRI as coordinator may cease, there will still be a strong need to maintain effective partnerships and to collaborate. Thus a framework that will respond to the continuing needs of NARS–ILRI partnerships in sub-Saharan Africa is essential. The joint development of new networking paradigms, based on shared information and knowledge, supporting research to extension and technology exchange, will become important activities during the 10-year period.

ILRI's global consultations with its partners in the regions of Asia, Latin America and the Caribbean, and Central Asia, West Asia and North Africa on the agenda for livestock research have underscored the continuing need for capacity building in the NARS. The campuses in Ethiopia and Kenya will remain the base for much of ILRI's training, but specific activities will be based and implemented at the most appropriate locations. Outside sub-Saharan Africa, ILRI will support existing livestock or livestock-related networks and build capacity within NARS–ILRI research projects.

Outputs

- Knowledge and information products developed for livestock R&D
- Information and technologies that ILRI generates into courseware to provide NARS with adult and distance education and training resources
- Delivery of livestock R&D information to a global audience
- Facilitation of the exchange of information on livestock R&D
- Strengthening of NARS capacity to develop and manage information systems
- Strengthening of capacity for NARS to do livestock research in both developing and developed countries, with special emphasis on early career scientists, and to incorporate policy formulation and research management into their research and extension activities
- Networking to build critical mass, optimize utilization of resources and ensure that their impact is positive

Delivery pathways

Information and knowledge products will be purveyed increasingly through Net-based technologies, in place of print media. Training to strengthen capacity will address both groups and individuals. Individual training will include increased reliance on visiting scientist, visiting scholar and post-doctoral arrangements involving the priority regions, systems and key research areas. Involvement in formal and informal networks as collaborating partners will help ensure relevance and responsiveness to NARS priorities.

Links

Transfer of information products is a principal mechanism for establishing and maintaining links among the research areas within ILRI and between ILRI and its partners.

Training is integrally linked with ILRI's research activities, driven by partner needs and ILRI–NARS collaborative research. Networking by definition is creating, maintaining and using links in an external environment, in this case among ILRI and partners. Training contributes to the capacity and the knowledge required for these links to operate successfully.

Impact on the poor and the environment

Information. Provision of information and knowledge both internally and externally to ILRI's partners—especially NARS—will enhance their capacity to undertake effective research. Products of NARS' own research and wider appreciation of the results of ILRI's research will result in resource-poor livestock keepers having access to better technology options. This will help to reduce poverty, increase food security and ameliorate harmful environmental effects.

Capacity. Training that responds to priority needs of NARS is assured of high impact because it is relevant and trainees can put their newly acquired knowledge into immediate use. Collaboration among partners means 1) joint and better planning and priority setting, 2) joint and more effective implementation of agreed activities and 3) pooling of resources in scientific mass and capital. Training and networking activities will build capacity for livestock R&D that will lead to increased productivity and ultimately contribute to reducing poverty, improving food security and protecting the environment.

3.6 A production-to-consumption systems approach: an integrative mechanism

The production-to-consumption systems approach will permeate all the key research and related areas of endeavour at ILRI as an essential and holistic integrating device, rather than a stand-alone key research area. Determining the problems and constraints that will define the research and related agenda will come from collaboration with NARS in joint, participatory activities. This will be a two-way process, with the research products being made available for adaptation and adoption into smallholder animal agriculture. This approach responds to concerns about the lack of impact from past livestock R&D efforts. Introducing this integrating paradigm has important implications internationally for the roles, responsibilities and location of ILRI staff.

The seven key areas will be integrated at two levels: at the planning stage based on participatory needs assessments, and at the validation stage in the field. This integration is important to achieve focus, relevance and impact and to exploit scientific synergies.

The production-to-consumption systems research paradigm in an ecoregion will involve staff in the field. ILRI scientists will provide the livestock component in a broader ecoregional consortium of scientists from other centres and from national and regional institutes. For research based outside ILRI's two principal sites in eastern Africa, ILRI will depend on partners for both the scientific capacity and the physical infrastructure for the livestock research components that are not strategic and for the non-livestock research components. This strategy will help ensure flexibility to respond to new opportunities, emerging issues and fluctuating financing, as well as minimize ILRI's institutional overheads and depreciation costs.

These field-based projects to come will focus on the market-oriented crop–livestock systems that have primary priority, as identified in Chapter 1. They will provide the necessary primary information to help set ILRI priorities and assess impact, and they will conduct collaborative research in the field to integrate results obtained in the different key research areas. The precise role that ILRI will play in research will vary, according to its comparative or complementary advantages in the various regions and the existence of alternative suppliers. One of ILRI's primary roles will be to conduct transregional analyses, to derive lessons of broad relevance, as for example, in market-oriented smallholder dairy systems.

3.7 CGIAR systemwide initiatives

To build synergies across its centres, the CGIAR has organized a number of intercentre initiatives that address issues of critical importance.

One of these is the Systemwide Livestock Programme (SLP), which ILRI convenes (see Box 3.1). It is the largest single CGIAR systemwide programme. As ILRI moves into a more catalytic mode, SLP is working with the CGIAR crop centres to meet the growing demand for pork and poultry meat, largely from industrialized systems and primarily based on feed grains. Specifically, attention is focusing on research to improve feed production and natural resource management on the farm.

ILRI's own research will be closely allied with research of ecoregional consortia, in which the significant input from crop centres and national partners ensures that natural resource management and other environmental research follows a true systems perspective rather than dealing with only a single component of an agricultural system.

Through SLP, the institute supports ongoing research in regional and ecoregional initiatives that include the African Highlands Ecoregional Programme, the Global Mountain Initiative, the Ecoregional Programme for the Humid and Subhumid Tropics of Sub-Saharan Africa (EPHTA), the Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN) and the Consorcio de Investigación sobre Sistemas de Producción Animal de Doble Propósito (TROPICLECHE)—all of the CGIAR—and consortia of centres and national partners in southern Africa, South-East Asia, and the West Asia–North Africa region. Other initiatives to which ILRI contributes are the Desert Margins Programme, the Inland Valleys Initiative, the Genetic Resources Initiative and the Initiative on Property Rights and Collective Action. Through consortia involving IFPRI and others, ILRI will contribute on topics such as livestock trade and policy, either directly or through SLP.

The Technical Advisory Committee of the CGIAR commissioned a recent evaluation of some of these initiatives. The review concluded that they were effective in managing interinstitutional collaboration. It is expected that the initiatives will continue over the mid to long term. And ILRI will continue to be involved in their activities.

Box 3.3

Systemwide Livestock Programme

The Systemwide Livestock Programme (SLP) seeks to—

- coordinate CGIAR resources invested in centre, ecoregional and other systemwide programmes in order to most effectively address development-oriented livestock research
- build and strengthen links with plant-oriented centres so as to develop coherent research and research-related programmes that contribute to the CGIAR's global livestock agenda

Under this concept, some research falls solely within ILRI and some is livestock-related research with common themes across centres. SLP research focuses on—

- impact assessment of feed and natural resource management technologies
- increasing feed quantity, quality and utilization
 - , áã éêçî áàò-ííéç=èì ~ääíó=çí-ííççç=Áèçéé=èÉèçì Éè
 - , ááíÉòè-íáàò-áÉòì áÉè--àç-áÉòì ááàçì è=íèÉÉè--àç=èÜèì Áè=ááíç=Òè-òáàòì=Áèçééáàò--àç=Áì í
 - ~àçJÁ~èèò=èòèíÉã è
 - , áã éêçî áàò=íÜÉ=ì èÉ=çí-Éñæíáàò-ííéç=èÉèçì èÁÉè
- natural resource management for improving productivity and sustainability of crop–livestock systems
 - , í áçÉèèí-áçáàò--àç=éèÉçáÁíáàò=èòèíÉã è=Éí çàì íáçà
 - , çÉí Éáçéáàò=èíè-íÉòáÉè=ííçè=ááíÉáèáííóáàò=á-áç=í èÉ
 - , áã éêçî áàò=áì íèáÉáí=èì ééáò--àç=í èÉ
- relevant policies
 - , ííéç=èì ééáò--àç=çÉã ~áçì--àç=áã éääÁ-íáçàè=ííçè-á-íì è-á-èÉèçì èÁÉ=ã ~á-òÉã Éáí
 - , Áçáèíè-ááíè=íç--ççéíáàò=íÉÁÜáçáçòáÉè=ííçè=ííéç=--àç=á-íì è-á-èÉèçì èÁÉè=ã ~á-òÉã Éáí

see file figs. 3.1–3.2 LAN for figures for this chapter; insert as pages 65–66

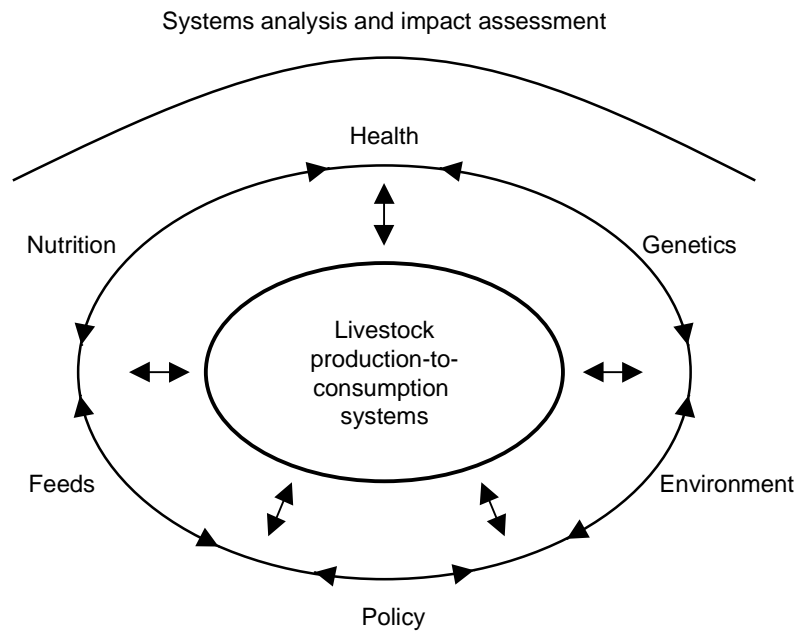


Figure 3.1 *Synergistic links among the key research areas that will have an impact on livestock production systems.*

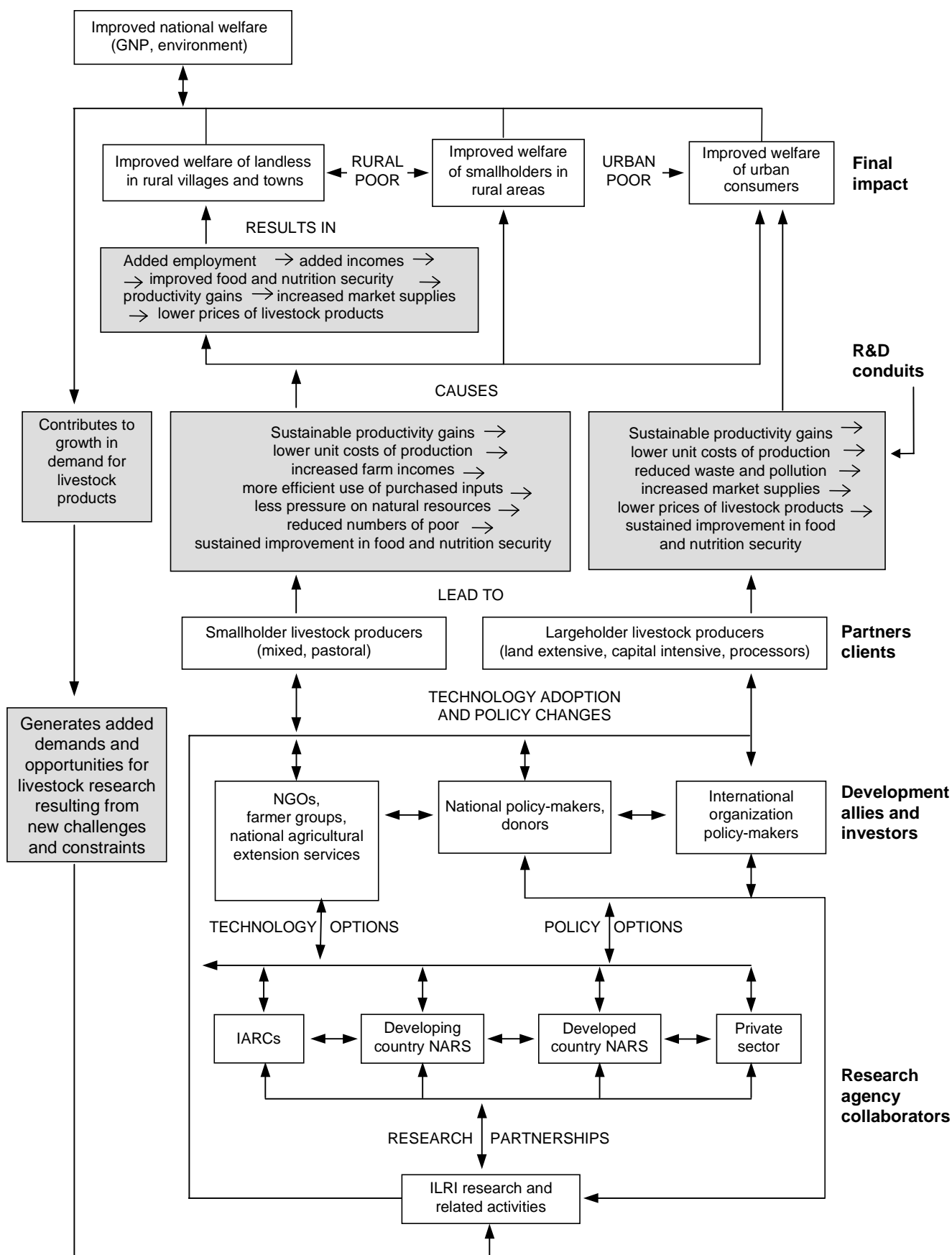


Figure 3.2 Pathways to desired impact for ILRI research and related activities.

4 Implementing the ILRI strategy

ILRI's priorities and plans for the next decade have been developed to address the opportunities arising from the increased demand for meat and milk—the Livestock Revolution—and the need to ensure that this revolution benefits the poor through poverty reduction, nutritional security and environmental protection. This chapter links ILRI's long-term strategy and the medium-term plans, which, following TAC guidelines, will make the strategy operational in a rolling series of three-year plans for activities and resource allocations. The first of these plans under ILRI's new strategy will be for the period 2001–03.

Having made the broad strategic decisions on what ILRI will do, the institution addresses strategic decisions on where and how the strategy will be implemented:

- new directions
- ILRI's strategic role
- resources for the agreed agenda
- priority setting and resource allocation
- resources management and mobilization
- organizational structure and management
- monitoring and evaluation
- governance

4.1 New directions

4.1.1 *Regions, systems and species*

The institute's programme will include a balanced portfolio of priority activities across regions, systems and species. It will implement a mixture of activities expected to yield results in the short, medium and long term to provide lasting solutions to the challenges facing smallholder livestock keepers in developing countries.

ILRI's priority geographic regions will be sub-Saharan Africa and Asia (Chapter 3). Its principal capacities are already in sub-Saharan Africa, and these capacities will be strengthened and focused over the next decade.

Since ILRI was created in 1994, the share of resources devoted to regions outside sub-Saharan Africa has increased (Table 4.1). This has led to a share of approximately 67% for sub-Saharan Africa, 21% for Asia, 10% for Latin America and the Caribbean, and 2% for West Asia and North Africa in 2000.

In response to the clear prospects for meaningful economic impact and the predominance of poverty in Asia and sub-Saharan Africa, ILRI will increase the share of resources for Asia towards 28% and reduce the share for sub-Saharan Africa to 63%. While the latter represents a small proportional but not absolute decline from current levels, the resultant share represents an appropriate recognition of both the special priority that the CGIAR accords to sub-Saharan Africa and ILRI's global responsibilities. The West Asia and North Africa region and the Latin America and Caribbean region will in future together represent 9% of the ILRI portfolio.

The priority production systems for ILRI attention are the rainfed mixed crop–livestock systems in the tropics and subtropics. All its research programmes will give these systems greater emphasis (see Box 4.1 and Table 4.2).

Table 4.1 ILRI regional expenditure (US\$ millions)

Region	1996 (actual)		1998 (actual)		2000 (proposed)		2005 (forecast)		2010 (forecast)	
	(\$ mill)	(%)	(\$ mill)	(%)	(\$ mill)	(%)	(\$ mill)	(%)	(\$ mill)	(%)
Asia	3.6	14	5.5	20	6	21	9	25	13	28
LAC	2.0	8	3.0	11	3	10	3	7	3	6
WANA	0.3	1	0.6	2	1	2	1	3	1	3
SSA	19.9	77	18.6	67	19	67	24	65	30	63
Total	25.8	100	27.7	100	29	100	37 ^a	100	47 ^a	100

LAC – Latin America and the Caribbean, WANA – West Asia and North Africa, SSA – sub-Saharan Africa

^a Estimated, as TAC recommended a 9.3% share of projected CGIAR funding of US\$420 for 2005 and US\$500 million for 2010

ILRI's resources are currently focused on ruminants. In the period towards 2010 the share devoted to research on swine and poultry will rise to 10%, primarily for research in epidemiology, systems analysis and policy. Of the 90% share for ruminants, half (45%) will support biological, systems and policy research relevant to both large (cattle, buffalo) and small (sheep, goats) ruminants; the other half will go to specific research on large ruminants (30%) and small ruminants (15%).

Box 4.1

Priorities for systems and species

East and South-East Asia—Focus on smallholder livestock systems involving ruminants (including buffalo) and monogastrics; and on swine and poultry in industrial systems for issues related to environment, food safety, human health, trade and markets.

South Asia—Focus for ruminants including buffaloes in mixed crop-livestock systems, with attention to poultry in mixed and industrial systems.

Latin America and the Caribbean—Focus on ruminants in smallholder mixed crop–livestock systems (including dual purpose cattle and camelids) and on environmental and policy issues for industrial livestock systems serving urban and export markets.

West Asia and North Africa—Focus on ruminants in stratified mixed and pastoral systems, including contributions to health, nutrition and genetics research with ICARDA and others.

Sub-Saharan Africa—Continued emphasis on ruminants in mixed crop-livestock systems; with attention to swine and poultry in both mixed and industrial systems, primarily by systems analysis and policy research.

4.1.2 ILRI's contribution to the CGIAR agenda

Since 1996, the share of ILRI's expenditures on the five basic undertakings of the CGIAR (see Table 4.3) has changed significantly. The shares going to protecting the environment and improving policies have risen, and those devoted to increasing productivity, saving biodiversity and strengthening NARS have reduced

Table 4.2 Relative emphasis for ILRI programmes by livestock production systems and principal agro-ecologies and geographic regions. The number of Xs indicates the relative emphasis

Livestock production systems and principal agro-ecologies ^a	Principal geographic regions ^b	Programmes						
		Integrative research	Intervention-generating research					Capacity strengthening for livestock research
			Systems analysis and impact assessment	Livestock feeds and nutrition	Livestock health improvement	Livestock genetics and genomics	Livestock policy	
Industrial systems								
Monogastrics—swine and poultry	all	X	—	—	—	X	X	—
Mixed crop livestock systems								
Irrigated humid/sub-humid tropics and subtropics	Asia	X	X	X	X	X	—	X
Rainfed humid and subhumid tropics and subtropics	Asia, LAC, SSA	XXX	XXX	XXX	XXX	XX	XXX	X
Irrigated arid and semi-arid tropics and subtropics	Asia, WANA	X	—	—	—	X	—	X
Rainfed arid and semi-arid tropics and subtropics	Asia, SSA, LAC, WANA	XXX	XXX	XX	XXX	XX	XXX	X
Irrigated temperate and cool tropics (highlands)	WANA, Asia	—	—	—	—	—	—	—
Rainfed temperate and cool tropics (highlands)	SSA, LAC, Asia	XX	XX	XX	XX	XX	XX	X
Pastoral grassland systems								
Humid and subhumid tropics and subtropics	SSA, LAC, Asia	X	—	X	X	X	X	X
Arid and semi-arid tropics and subtropics	SSA, WANA	X	—	X	X	X	X	X
Temperate and cool tropics (highlands)	SSA, LAC, WANA	X	—	X	X	X	X	X

LAC – Latin America and the Caribbean, WANA – West Asia and North Africa, SSA – sub-Saharan Africa

^a Principal agro-ecologies as specified by Seré and Steinfeld (1996)^b Principal geographic regions where production systems are important or expected to become important over the next 10 years

In view of the re-emphasis on poverty reduction and prospective economic impact as the overarching criteria for assessing priorities at ILRI, the share of resources forecast for 2010 to increase productivity in systems involving resource-poor smallholder livestock keepers will decrease slightly to 60% (Table 4.3). Because of the importance of policy in creating the enabling environment for productivity-enhancing technology adoption and impact, its share will rise to 8% from the current 5%. The share to strengthening NARS will increase to 9%, largely from devolving responsibility for coordination of networks to the subregional organizations over the next 10 years. The proportional emphasis on protecting the environment will increase to 15% over the same period and on saving biodiversity to 8%.

Table 4.3 ILRI expenditure by CGIAR activities and undertakings (US\$ millions)

Undertaking	1996 (actual)		1998 (actual)		2000 (proposed)		2005 (forecast)		2010 (forecast)	
	(\$ mill)	(%)	(\$ mill)	(%)	(\$ mill)	(%)	(\$ mill)	(%)	(\$ mill)	(%)
Increasing productivity	16.3	63	16.9	61	18.3	63	22	60	28	60
Protecting the environment	1.4	5	3.4	12	3.7	13	6	15	7	15
Saving biodiversity	2.3	9	2.4	9	2.0	7	3	9	4	8
Improving policies	1.2	5	1.5	5	2.1	7	3	7	4	8
Strengthening NARS	4.6	16	3.5	13	3.0	10	3	9	4	9
Total	25.8	100	27.7	100	29.1	100	37 ^a	100	47 ^a	100

LAC – Latin America and the Caribbean, WANA – West Asia and North Africa, SSA – sub-Saharan Africa

^a Estimated, as TAC recommended a 9.3% share of projected CGIAR funding of US\$420 for 2005 and US\$500 million for 2010

In future, 80% of ILRI's resources will support strategic and applied research, with half of this research at the discovery end of the discovery–delivery–impact continuum and half in applying analytical methodologies, analysing constraints, evaluating interventions in the field, and assessing impact. The other 20% of the resources will focus on the delivery end of the continuum, including strengthening capacity and information services, facilitating adoption of interventions, and generating public awareness and support for sustainable livestock development.

4.2 Defining ILRI's strategic role

4.2.1 Partnerships and alliances

The enormous challenges outlined in Chapter 2 are far more than ILRI can address alone. The institute will work through partnerships, alliances and consortia with other institutions to effectively implement this strategic plan. These partnerships will be guided by a set of agreed precepts:

- Significant synergies exist among the partners.
- All parties are committed to ensuring the partnership succeeds.
- Through joint planning, clear roles and responsibilities are defined for each partner.
- The partners agree to contribute resources, including people, finances and time, to the agreed objectives and plans.
- There is agreement on sharing recognition and ownership of intellectual property rights resulting from the partnership (see Box 4.2).
- There is a clear understanding on the time frame for the partnership and the rules of management and disengagement.

Box 4.2**Managing intellectual property**

ILRI is a public-funded institute producing international public goods. Changes in attitudes towards intellectual property rights will influence the implementation of the programmatic choices that ILRI makes. Issues of intellectual property will be key when forging new partnerships for implementing programmes, especially in partnerships with the private sector for delivering technologies that ILRI has developed. ILRI will follow the principles set out in the ILRI Policy on Intellectual Property Rights, Biosafety and Bioethics (ILRI 1998) in handling intellectual property issues. ILRI will endeavour to

- maintain the results of its publicly funded research in the public domain
- use clear agreements for proprietary technology to ensure that the products of ILRI programmes remain available to smallholder farmers
- make technologies or tools that do not include proprietary technology freely available
- use publications, contractual provisions, material transfer agreements, defensive patenting or the ILRI logo to ensure that such information, invention, or material remains in the public domain

Exceptions to this principle will be made where distribution of products or publication of information in the public domain must be limited for confidentiality reasons to ensure continued availability to developing nations. ILRI recognizes that intellectual property protection on its products and technologies may be necessary

- to ensure continued availability of germplasm, inventions, publications and databases to ILRI clients and prevent their being misappropriated by others for profit making
- to ensure the delivery of improved products and technologies in developing countries
- to negotiate access to other proprietary rights and technologies required for product development

ILRI recognizes that partnerships are a mechanism that allows the pooling of resources to attain an agreed objective. It also recognizes that a partnership mode of operation requires time of scientists to establish confidence and credibility among the partners and is management intensive. It believes this investment has handsome payoffs in terms of enhancing capacities for livestock research, multiplicative effects generating scientific and economic spillovers, and leveraging additional resources for research.

ILRI will work a range of partners:

- national research institutions in developing countries
- regional and subregional organizations responsible for coordinating and conducting research
- centres of the CGIAR and the systemwide and ecoregional programmes that they are convening
- advanced research institutions
- the private sector
- development agencies including NGOs, government extension agencies, international and bilateral development organizations

4.2.2 Role for ILRI

ILRI will continually assess where in the research continuum, from discovery to delivery to impact, it should apply its limited resources. This will be determined by analysing the comparative advantages of alternative suppliers and the opportunities for complementarity through partnerships, consortia and strategic alliances.

The severity of a particular problem, the potential that results from working on it have for impact and for spillovers to other regions, the availability of partners, and the local cost-effectiveness of performing the particular tasks will determine where geographically ILRI will conduct the required activities. ILRI recognizes that its priorities, choice of partners and mode of operation will be increasingly influenced by the strategies and goals of national and subregional organizations covering the locations at which ILRI plans to work.

ILRI is well placed to be a catalyst for applying 'new science' to enhancing smallholder livestock productivity. The new sciences include genomics, molecular biology, animal health, environmental decision-support tools, spatial analysis, environmental monitoring, application of animal models in human and environmental health, information collation, retrieval and dissemination technology, and knowledge systems. Effective partnerships with the leading international centres of excellence associated with the new sciences will be essential.

In view of the enormity of the challenges, ILRI will use its position of international leadership to advance the global international agenda for livestock research through different roles appropriate to the task at hand and the relative strengths and interests of alternative research providers (see Box 4.3). The underlying principles that will determine ILRI's role will be

- the strength of ILRI's interest based on strategic priorities
- the availability and comparative or complementary advantages of alternative research providers
- the degree of support and endorsement of host country and regional and subregional stakeholders
- the availability of required infrastructure with minimal capital investment needs
- the availability of funding: the effect of this principle will depend on partners' ability to convince investors of the merit of the tasks; also heavily influencing investor interest will be the level of conviction that ILRI's involvement will enhance the impact and cost-effectiveness of the overall research effort

ILRI's roles (see Box 4.3) will vary depending on the type of research, the region and the production system that is the focus of the work.

Box 4.3

Roles for ILRI

ILRI sees for itself five roles:

A leading role for international livestock research: As the only livestock research centre with a global mandate, ILRI is responsible for leading international livestock research.

Responsibilities include determining and setting priorities on the researchable issues and helping mobilize resources for the most appropriate research providers.

A primary role means that ILRI scientists will be making a major direct contribution to the research. ILRI may orchestrate the combined efforts of the team of partners who are all working on their respective components of the problem. Or another partner may be in the leadership position, with ILRI scientists actively involved in component research that directly addresses the problem being tackled.

A catalytic role entails ILRI contributing to, initiating or directing an area of work, creating awareness of a problem, accelerating progress or providing key missing elements. ILRI must have core capacity in the area of work to be an effective catalyst.

A facilitative role means that ILRI uses its expertise and resources to assist other partners to address a problem, even if ILRI scientists are not working directly on the problem. Involvement in and coordination of networks is a good example of this type of role. Capacity building, by training or by supplying information and knowledge, is also included in this category.

A convening role, such as for the systemwide and ecoregional programmes, involves other CGIAR centres, NARS and regional or subregional organizations interested in a common problem. The convenor role stems from the mandate, location and experience of the centre most directly concerned about the particular problems being addressed. As the convenor for the Systemwide Livestock Programme, ILRI oversees the governance of the programme, organizes the consultative planning and reporting processes, assists priority setting and resource allocation, and manages the finances and accounting to the investors for programme grants.

4.2.3 Delivery pathways

Effective delivery of research products is vital if the results of ILRI's research are to achieve impact. Delivery will be through research and development agents such as FAO, NARS, NGOs and the private sector, depending on the nature of the research product to be delivered. Knowledge-based products will usually be delivered through NARS and NGOs, while tangible products, especially those requiring manufacture, sales and distribution, will increasingly mean involving the private sector (see Figure 3.2). Here, suitable intellectual property and licensing arrangements will need to be negotiated—to protect the interests of ILRI and its partners, but also to secure the involvement of private sector partners. Safeguards will be built in, however, to ensure that resource-poor producers and consumers are advantaged as a result.

Strategies that ILRI employs to achieve impact with its various clients, partners and stakeholders are

- engaging farmers in the participatory research process, in which farmers themselves are research partners and experimenters
- developing and strengthening alliances with organizations that complement the skills and expertise of ILRI to maximize impact and spillovers (NGOs, farmers' organizations, NARS, the private sector, government extension agencies)
- developing mechanisms to ensure that technical information is moved 'off the shelf' and made accessible to various clients and stakeholders

ILRI recognizes that its partners have a shared need and responsibility to achieve impact through delivery. ILRI has an important facilitative role to play with its partners to ensure that the institute's mandate is fulfilled and the livelihoods of millions of the poor are improved through livestock R&D. Section 3.6 in Chapter 3 outlines how each research area plans to ensure that outcomes from research will have impact.

4.3 Resourcing the agreed agenda

4.3.1 Links between priorities and resource allocations

The outputs of the priority assessment process will provide the basis from which activities emerge as priorities on ILRI's agenda. The links between impact assessment, future priority assessment and resource allocation are shown in Figure 1.1 and Section 3.5. The results from impact assessment studies will act as feedback to allow the priority assessments to be adjusted and refined.

The process of assessing priorities, based upon a composite index, clusters the candidate research themes into high-, medium- and low-priority groups. This clustering provides a broad indication of which themes emerge as priorities on ILRI's agenda. Within these broad categories, the activities will also be arrayed in order of priority based upon the composite index scores for each research area along with the notional resource requirement for that area; this process clearly links priorities with resultant resource allocations. The cumulative notional resource requirements will demonstrate the total resources required over time to implement the research. These resources represent the marginal variable costs of implementing the projects, excluding the 'overhead' and 'sunk' costs of physical infrastructure.

4.3.2 Mobilizing financial resources

Since 1995, the CGIAR agenda funding has expanded from US\$270 million to US\$340 million in 1999. The number of investors has increased from 49 to 58. This growth has been almost exclusively increases in restricted project funding. The CGIAR funding in 2000 is projected at the same level as in 1999—a decline in real terms. But a modest increase to US\$420 million in 2005 and US\$500 million in 2010 is projected as the basis for estimating ILRI's funding, as the TAC-recommended 9.3% share.

ILRI's funding has increased from US\$23.8 in 1995 to US\$28.1 in 1999. The increase is entirely restricted funding, which currently represents 54% of the overall budget. From 1995 to 1999, the number of investors in ILRI has increased from 28 to 45; 95% of these are CGIAR members.

TAC has recommended that investment in ILRI be approximately 9.3% of the total CGIAR portfolio, an increase from the current 8.1%. Based on that recommendation, ILRI's funding target is US\$37 million for 2005, comprising

35% unrestricted funding, 25% programme restricted and 40% project restricted, with 75% of the funding from CGIAR members and the balance from new investment sources.

Unrestricted finances are particularly valuable to ILRI. They provide the institute with the flexibility to be innovative as well as ensure successful completion of longer-term priority research. Nevertheless, a continuing decline in the percentage of unrestricted financing in the overall budget is expected. Therefore, the following priorities will guide the allocation of these funds:

- initiating new and innovative priority activities
- filling gaps and shortfalls in ongoing activities
- leveraging funds from partners and donors giving restricted funds
- supporting essential programmatic and institutional management

Unrestricted funds will not be used for the continuing operational costs of projects that do not attract significant donor support. Once research initiatives are established, project leaders must secure targeted funding to meet operational costs. Generally, a consortium of investors will support the priority research of ILRI and partners.

ILRI will intensify its efforts to expand and diversify its investor base. Its resource mobilization strategy addresses the following objectives:

- sufficient funding to implement the priority research agenda
- continuity of funding over time to complete priority research once started
- dependable sources of funding—in both long-term investors and consistency in funding from year to year
- flexible funding—to initiate new research and pursue innovative and emerging opportunities to bring the best science to the needs of the poor
- greater diversity in funding—to broaden the base of the CGIAR investors and expand the set of supporters from the private sector (foundations, philanthropists and for-profit organizations) and from public sector agencies supporting human health and environmental research

Principles guiding the resource mobilization strategy are

- maintaining the group of investors (the CGIAR members) who have invested in ILRI in the last five years
- identifying new investors who are not customary investors in the CGIAR but have interest in international research
- developing a more aggressive and targeted public awareness programme as an integral part of the resource mobilization strategy
- ensuring a close link with CGIAR efforts on resource mobilization through Future Harvest: the CGIAR Foundation.

The resource mobilization strategy will involve all staff, a strong commitment from the Board and senior management, and an increased investment in public awareness and funding. ILRI's public awareness programme builds intellectual and financial support for the institute. Public awareness focuses on current and potential investors and their constituencies. ILRI public awareness materials and events will

- help persuade donors that investment in ILRI research serves their development goals
- demonstrate that investors and ILRI share the same interests and core values
- make explicit the impacts of ILRI research and the ‘add-on’ value of livestock research to agricultural and development projects
- help build bridges between science-oriented and development-oriented communities by focusing on issues of major public concern—such as poverty, hunger, environmental degradation, public health, materially deprived children and gender equity—among donor countries and agencies

4.3.3 Human resources

Increasingly, ILRI will depend on partnerships and strategic alliances to build the critical mass of skills and resources required to achieve impact through tactical contributions to international livestock research within the discovery–delivery–impact continuum. Core capacity will be maintained in key disciplines to provide platforms of activity, expertise and credibility to bring in additional resources to fulfil ILRI’s mandate.

ILRI will have a set of 65 internationally recruited core positions, of which 50 will provide for programme and project leadership and management, 5 will manage programme support units and 10 will provide institutional leadership and management. Additional internationally recruited but non-core positions will be filled, usually on a fixed-term contract, as needed and as funding permits. In future, more work will be done with and through scientists from partner institutions.

A principal responsibility of those in core positions will be to manage project resources, integrate activities within and among projects, and ensure that the planned outputs and impact are achieved. ILRI’s core positions will combine scientific leadership qualities with high-level management skills to foster and implement successful multi-institutional, multidisciplinary and multisite projects and programmes. These attributes of ILRI’s core scientific positions will provide challenging and rewarding career opportunities for experienced scientists and research managers. Investing in improving these essential scientific and managerial skills will be a priority for ILRI’s programme for developing human resources.

Programme implementation will be done primarily through teams, many of which will be a mix of ILRI and non-ILRI staff. To the extent that increased numbers of staff are employed or contracted for short periods, the challenges to manage the human resources increase. Managers will need to manage team continuity and continued productivity in the face of a changing staff mix. Skills will be developed to enable effective team-based work planning and the management of teams that are multicultural and geographically dispersed. ILRI will increase its attention to attracting and retaining high-quality and productive staff.

4.3.4 Physical resources

ILRI’s headquarters are in Nairobi, Kenya, with principal campuses in Nairobi and Addis Ababa. Both campuses host other international centres and intercentre

programmes. They provide facilities for a wide range of research and research-related activities across all programmes. ILRI's assets at these sites include cadres of skilled and committed nationally recruited technical and administrative staff.

ILRI also enjoys the goodwill of the host country governments in Kenya and Ethiopia, without which the institute's capacity to do research would be most severely curtailed. For example, the increased concerns in the South about sovereign rights over genetic resources means that official approval is required for international exchange of research materials, and that depends on the trust and confidence of the host country. Government support also facilitates the establishment of partnerships in the host countries.

Over the longer term, the depreciation costs for physical infrastructure affect variable costs and ILRI will, therefore, periodically reassess the utility of its facilities in the light of emerging research priorities. An assessment of future deployment of the facilities in Ethiopia is scheduled for 2001.

ILRI's new activities outside Kenya and Ethiopia will not require significant investment in infrastructure because there will be greater reliance on the established infrastructure and goodwill enjoyed by CGIAR centres and NARS in countries where the new projects will be implemented. For example, the team in South-East Asia will be based at IRRI in the Philippines and for South Asia, at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India. In West Africa, the ILRI team will be based at the International Institute of Tropical Agriculture (IITA) in Nigeria. In Latin America and the West Asia and North Africa regions, ILRI scientists will be based with fellow centres, following the model of joint positions currently in place in Colombia with the Centro Internacional de Agricultura Tropical (CIAT) and in Peru with the Centro Internacional de la Papa (CIP). In turn, ILRI will make physical capacity and the appropriate provisions in its host country agreements in Kenya and Ethiopia available to fellow centres working in these countries.

4.4 Organization and management

4.4.1 Organization and structure

Organization and management of a decentralized, multidisciplinary, multipartner and multicultural institute will present many challenges. ILRI will adopt a structure that will allow growth and flexibility to address the multiple demands from stakeholders, yet be accountable and provide continuity and stability for long-term livestock research in a changing external environment.

The principal unit for programme implementation will be the operating project. Projects will be aggregated into problem-oriented, multidisciplinary programmes that address the priority themes identified within the seven key research and related areas where ILRI will focus its limited resources.

ILRI's operating projects will fall into two general categories: those for which objectives and activities fit within one of the seven priority programme areas, and those that address a priority livestock production-to-consumption system. The latter type of project will diagnose constraints, develop interventions from research results from ILRI's programmes and other sources, evaluate the interventions under field conditions, and assist the development and delivery of proven interventions. Typically, these production-consumption systems projects will be implemented through a broad set of partners with ILRI responsible for leadership, coordination and catalytic scientific contributions.

4.4.2 Institutional and programme management

ILRI's international mandate and holistic systems approach will require entrepreneurial, flexible and responsible management. ILRI's core programme positions will combine requirements for scientific leadership with managerial expertise.

The Deputy Director General–Programmes (DDG-P) will provide the overall leadership and management of ILRI's research and related programmes and programme-support capacities. Major responsibilities will include integrating activities among and within programmes, coordinating priority setting, planning and monitoring to ensure high-quality and relevant activities and outputs, and ensuring appropriate partnerships and alliances with NARS, ARIs and IARCs. The DDG-P will also assist the Director General and Office of External Relations with resource mobilization.

ILRI will use project-based management to ensure accountability and quality. The project plan will specify objectives, experimental design, milestones, outputs, resource requirements and completion date.

The core leadership positions within programmes will be the programme coordinators. They will provide scientific and managerial leadership, assist resource mobilization, engage effective partnerships, and ensure quality and productivity. The programme coordinators will be expected to contribute directly to research and as a group to assist the DDG-P with overall programme management.

The project leaders will be responsible for conceptual and technical leadership and for managing financial, human and other resources, including those provided through partnerships; they will report to the programme coordinators. Leaders of the priority production–consumption systems projects, which cross programmes and involve complex interinstitutional linkages, will report to the DDG-P.

The other main area of functional responsibility is Corporate Services, which encompasses four main areas: Human, Financial, Information Technology and Physical, each with a manager. It also assists in the resource mobilization efforts of the institute. Corporate Services provides leadership to mobilize and use financial, human, information and physical resources to support the programmes in the most cost-effective and efficient way to enable ILRI to achieve its objectives.

Excellent communications will be essential to support the management of ILRI's decentralized programme. Internet technologies will integrate telecommunication facilities with the computing infrastructure to provide fast, cheap communication with better tools to render separation by distance irrelevant.

Major responsibilities of the Director of Corporate Services include corporate planning, implementing appropriate policies and procedures, supervising the operations of the corporate services at ILRI, and developing and managing agreements and contracts with partner institutions and governments.

Management and development of relations with investors are coordinated by the Office of External Relations. Important functions include marketing the institute through public awareness and resource mobilization strategies. This office is led by the Director of External Relations, who reports to the Director General.

4.4.3 Programme monitoring and evaluation

ILRI will employ rigorous priority setting and planning mechanisms to maintain focus and establish milestones on which to judge progress and achievements.

The basic planning framework for ILRI is this longer-term strategy. From this, other mechanisms will enable the institute to refine priorities in the rolling medium-term plans and the annual programme of work and budget. These three documents are the principal planning instruments.

The medium-term plan provides the planning framework for the detailed annual plans and budgets for ILRI activities, which are consolidated in the annual programme of work and budget. This annual programme is a decision-support tool that outlines the scope of the work and the resources required to implement the plan.

ILRI will systematically assess the extent to which it is achieving its objectives as a regular feature of its monitoring and evaluation activities. This is in recognition of the commitment in its new mandate statement that it will 'measurably and sustainably improve the livelihood of resource-poor livestock keepers, make animal products more affordable and accessible for the poor and conserve natural resources in developing countries'. To do this effectively will require developing assessable indicators of success and impact that allow comparisons both over time within ILRI and across space with other benchmarks or comparator organizations. The principal indicator will be the impact that ILRI research and technology developments have on farmers. Other indicators will include

- number and quality of refereed scientific publications
- number and types of strategic alliances
- type and extent of cross-programme and cross-project synergies
- number of new donors, especially non-customary ones
- rising share of restricted funding and increased level of total funding
- extent to which ILRI resources leverage those from partnerships and collaboration

ILRI will systematically measure and document the *ex post* impacts of its research and related activities as key indicators of its progress towards fulfilling its mandate. These studies will include the impacts on poverty, food and nutrition security, the environment, and the livestock research and development capacity of NARS. Non-ILRI staff will conduct some of the studies. They will be externally peer reviewed to enhance their credibility. Milestones and indications of impacts, identified in research plans and log frames, will be used as explicit inputs into monitoring and evaluation. The extent to which such assessments lead to significant changes in direction or resource allocations or both by means of the priority assessment framework will be a further validation of the seriousness of ILRI's commitment to its mandate.

ILRI is committed to providing strong scientific leadership in the key research areas to ensure scientific excellence and quality of its programme. Mechanisms to ensure both relevance and scientific quality include

- rigorous annual planning, reporting and review procedures
- internal in-depth peer reviews to improve focus, assess scientific quality and determine options and future direction
- quinquennial review of individual international staff for scientific excellence and the continued relevance of their skills and experience
- centre-commissioned external reviews to review the quality of the science and progress against the goals and outputs

Issues of intellectual property and confidentiality agreements with partners, especially with the private sector, will increasingly affect the information made available through publications in the future (see Box 4.2).

4.4.4 Financial management and accountability

The strategy and the medium-term plan lead in formulating and implementing the institution's annual programme of work and budget. The budget is a critical management tool for allocating resources to the annual work programme and for providing timely feedback to project and institutional managers. The significant shift in balance from unrestricted donor resources to project-restricted funding necessitates building project budgets in such a way that the full cost, including institutional support, is recovered.

While the institute is engaged in research activities of medium to long term, funding commitments are normally provided annually. The time lag between pledges of funding and actual disbursements exposes the institute to foreign exchange risks as well as cash-flow problems. To help ensure continuity of priority research and mitigate crises from unexpected donor decisions, ILRI will maintain reserves at or above the CGIAR recommended 90 operating days. Draw-down on reserves requires Board approval.

4.5 Governance

Over the next decade, ILRI's governance will need to respond to major challenges in the institute's internal and external environment. External challenges include issues of intellectual property in access to technologies and resources; ethical concerns, including animal care and use; and production and use of genetically modified organisms in ILRI research. ILRI will also be guided by the principles of Agenda 21 and the international conventions on combating desertification, protecting biodiversity and climate change.

ILRI's Board and senior management will be increasingly concerned with complex issues arising out of multi-institutional partnerships and strategic alliances, such as protection of intellectual property. Depending on whether ILRI is a contributor, contractor, convenor or leader, there will be different governance issues concerning the extent to which the institute is responsible and accountable to investors for the productivity and resources used by third parties in ILRI-led consortia and strategic alliances. In the next decade, these issues will become more intricate as ILRI increases its collaboration with non-governmental and private for-profit organizations, in addition to expanding partnerships with NARS, ARIs and fellow centres.

References

- CAST (Council for Agricultural Science and Technology). 1999. Animal agriculture and global food supply. Task Force Report no.135. CAST, Ames, Iowa.
- CGIAR (Consultative Group on International Agricultural Research). 1998. *The International Research Partnership for Food Security and Sustainable Agriculture*. Third System Review. CGIAR, Washington, DC.
- de Haan C., Steinfeld H. and Blackburn H.W. 1997. *Livestock Environment Interactions: Finding a Balance*. Report of a study coordinated by FAO, USAID and the World Bank. FAO, Rome.
- Delgado C., Rosegrant M., Steinfeld H., Ehui S. and Courbois C. 1999. *Livestock to 2020: The Next Food Revolution*. Food, Agriculture, and the Environment Discussion Paper 28. IFPRI/FAO/ILRI (International Food Policy Research Institute/Food and Agriculture Organization/International Livestock Research Institute), Washington, DC.
- Devendra C. and Gardiner P (eds). 1995a. *Global Agenda for Livestock Research: Proceedings of the Consultation for the South Asia Region, ICRISAT Asia Center, Patancheru, India, 6–8 June 1995*. ILRI, Nairobi. 146 p.
- Devendra C. and Gardiner P (eds). 1995b. *Global Agenda for Livestock Research: Proceedings of the Consultation for the South-East Asia Region, IRRI, Los Baños, The Philippines, 10–13 May 1995*. ILRI, Nairobi.
- Devendra C, Thomas D., Jabbar M.A., and Kudo H. 1997. *Improvement of Livestock Production in Crop-Animal Systems in Rainfed Agro-ecological Zones of South-East Asia*. ILRI, Nairobi. 116 p.
- Devendra C., Smalley M.E. and Li-Pun H. (eds). 1998. *Global Agenda for Livestock Research: Proceedings of a Conference on Development of Livestock Research Priorities in Asia, National Institute of Animal Husbandry, Hanoi, Vietnam, 13–15 May 1997*. ILRI, Nairobi. 49 p.
- Devendra C., Thomas D., Jabbar M.A. and Zebini E. In press. *Improvement of Livestock Production in Crop-Animal Systems in Agro-ecological Zones of South Asia*. ILRI, Nairobi.
- Gardiner P. and Devendra C. (eds). 1995. *Global Agenda for Livestock Research: Proceedings of a Consultation, ILRI, Nairobi, Kenya, 18–20 January 1995*. ILRI, Nairobi.
- Gryseels G., Groenewold J.P. and Kassam A. 1997. TAC database for quantitative analysis of CGIAR priorities and strategies. TAC Secretariat, Rome.
- ILRI (International Livestock Research Institute). 1998. ILRI's policy on intellectual property rights, biosafety and bioethics. [online: <http://ilriepdc/ilri/intra/ipr-pol.htm>]
- Livestock in Development. 1999. *Livestock in poverty-focused development*. Crewkerne: Livestock in Development.
- McCalla A. 1998. *The Global Challenge: the World Food Prize*. Symposium: Urbanization and Food Security, Des Moines, Iowa. p 7–8.
- McCalla A., and de Haan C. 1998. An international trade perspective on livestock and the environment. In: Nell A. (ed), *Livestock and the Environment: International Conference*. Proceedings of the conference, 16–20 June 1997, Ede/Wageningen, The Netherlands. Wageningen: International Agricultural Centre. p 13–21.
- Neuman C. and Harris D.M. 1999. *Contribution of Animal Source Foods in Improving Diet Quality for Children in the Developing World*. World Bank, Washington, DC:
- Ruiz M.E., Seré C., Li-Pun H. and Gardiner P. 1995. *Latin American and Caribbean Livestock Research Priorities: Summary Report*. Report on an ILRI, IDRC, IICA meeting held 16–20 October 1995, San Jose, Inter-American Institute for Cooperation in Agriculture, San Jose.

- Seré C. and Steinfeld H. 1996. *World Livestock Production Systems: Current Status, Issues and Trends*. FAO Animal Production and Health Paper 127. Food and Agriculture Organization of the United Nations, Rome.
- TAC (Technical Advisory Committee). 1996. *CGIAR Priorities and Strategies*. Consultative Group on International Agricultural Research, Document no. SDR/TAC:IAR/96/6.1 April 22. TAC Secretariat, Rome.
- TAC (Technical Advisory Committee). 1999. Report of the First External Programme and Management Review of the International Livestock Research Institute (ILRI). TAC Secretariat, Rome. Unpublished report.
- TAC/CGIAR (Technical Advisory Committee/Consultative Group on International Agricultural Research). 1993. *Priorities and Strategies for Livestock Research in the CGIAR*. AGR/TAC: IAR/93/6. TAC Secretariat, Rome.
- Vercoe J., Coffey S., Farrell D.J., Rutherford A., Winter W.H. 1997. *ILRI in Asia: An Assessment of Priorities for Asian Livestock Research and Development*. ILRI, Nairobi. 62 p.
- von Kaufmann R.R. In press. Livestock development and research into the new millennium, ILRI working document. Nairobi: International Livestock Research Institute.

Appendix—Issues and implications arising from external influences on ILRI's strategy

External influences (issues and implications from Chapters 1 and 2)	Research-able factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
1.1 ROLE OF LIVESTOCK IN POVERTY ALLEVIATION, FOOD AND NUTRITIONAL SECURITY, THE ENVIRONMENT AND HUMAN HEALTH			
1.1.1 POVERTY AND FOOD SECURITY			
Crop–livestock and grassland systems: Priority should be accorded to productivity-enhancing livestock R&D for mixed crop–livestock systems to have major economic impact on the bulk of the poor in developing countries. Grassland systems offer less scope for technical interventions that can directly benefit the poor, but natural resource conservation and management and relevant policies to sustain livelihoods are researchable needs.	yes	yes	ILRI research will focus on crop–livestock systems. ILRI will not be involved in developing technologies for grazing systems. However, ILRI will be concerned with natural resource management issues, including plant and animal biodiversity and policies affecting pastoral land use and management. Incorporated in ILRI's agenda, see Table 2.1.
Changing livestock systems: <i>Demographic and economic changes are causing rapid evolution of production systems within and across regions and agro-ecological zones. Setting priorities and designing research must take account of these evolutionary changes in identifying future needs. There are also opportunities for South–South exchange among regions at different stages of development.</i>	yes	yes	ILRI will take these evolutionary changes into account in setting priorities and designing research, and it will seek opportunities for South–South exchanges among regions at different stages of development. Incorporated in ILRI's agenda, see Table 2.1.
Distribution of the poor: <i>The geographical distribution of the poor, at regional, sectoral, agro-ecological and system levels, needs to be considered, to assess priorities that will more effectively address their needs.</i>	no	yes	ILRI will give highest priority to sub-Saharan Africa and Asia, where the majority of the poor reside. And ILRI's research portfolio will be built on projects that will have high impact on alleviating poverty.
Projected food price trends: <i>Animal-source food prices need to be monitored to establish if the projected decreases in price of animal food products actually occur and the poor have better access to meat and dairy products as a result of research-based technologies that increase productivity of systems.</i>	yes	yes	The effect of increased production on food prices will be a feature of ILRI's ex-post evaluation of research products. Incorporated in ILRI's agenda, see Table 2.1.
Poverty and nutritional security: <i>Technology and policy options are needed to optimally balance income generation with nutritional security and facilitate decisions that will improve diets in both the household and the nation.</i>	yes	no	This area is of interest because of the nutritional value of meat and milk; however, other providers are better placed to address human nutritional and dietary issues including the assessment of nutrition needs, nutrition education and extension.
Non-food uses of livestock including income generation: <i>Non-food uses of livestock, though declining in importance relative to food production, will continue to be important in the livelihoods of smallholders and in the sustainability of crop–livestock systems. Of particular importance is the impact on the finances and labour of women and the value of livestock as an asset in building financial security.</i>	yes	yes	The holistic farming-systems approach ILRI has adopted will encompass non-food uses of livestock, and ILRI's ex-ante and ex-post impact assessments will address gender and equity issues. Incorporated in ILRI's agenda, see Table 2.1.

External influences (issues and implications from Chapters 1 and 2)	Research-able factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
1.1.2 LIVESTOCK AND THE ENVIRONMENT			
Livestock and the environment: <i>Environmental impact methodologies and assessments are needed for all livestock R&D activities.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Crop–livestock systems: <i>Livestock technologies need to optimize whole-farm productivity gains and environmental enhancement by integrating crop and livestock production.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Natural resource management: <i>Livestock land-use practices affect air, soil, water management, and plant and animal biodiversity. Policies affecting access to common property, especially in extensive grazing areas, are critical for managing natural resources.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Industrial and peri-urban systems: <i>Technological and policy options are needed to address the environmental and public health issues associated with industrial livestock production systems, which are often located in densely populated areas.</i>	yes	yes	ILRI's research on environmental issues will contribute to improved sustainability of different production systems, including industrial and peri-urban systems. However, ILRI will directly focus on smallholder crop–livestock systems. Incorporated in ILRI's agenda, see Table 2.1.
Environment and public health: <i>Technological and policy options are needed that mitigate the negative and promote the positive interactions between animal agriculture, the environment and human health.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Climate change: <i>Research is needed on the impact both of livestock on climate change and of climate change on the evolution of livestock production systems, and the implications both have for livestock R&D.</i>	yes	no	Research on climate change requires long-term and global coverage. ILRI will endeavour to reduce the adverse contribution of livestock but will not conduct research on global or regional climate change.
Biodiversity: <i>The effects intensified livestock production have on the continued survival of indigenous livestock breeds and their actual and potential use will be an important aspect. Studies of biodiversity also need to assess the impact that increased competition for land for cropping will have on animal and plant biodiversity of rangelands.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Wildlife–livestock interactions: <i>Research is needed to provide information on wildlife–livestock interactions and to develop and validate tools used to support decisions on wildlife that will enable resource-poor livestock owners to make better decisions and obtain greater value from wildlife and thereby contribute effectively to conserving wild animal biodiversity.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.

External influences (issues and implications from Chapters 1 and 2)	Research-able factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
1.1.3 HUMAN HEALTH			
Impact of improved nutrition, especially on women and children: <i>There is a need to monitor the effect that changes in the price of livestock products have on consumption patterns and human nutrition status, especially of women and children.</i>	yes	no	ILRI will continue to facilitate research by appropriate specialized institutions interested in quantifying the effects of meat and milk supplements to poor people's diets.
Zoonoses: <i>Regulatory policies and technological solutions are needed to minimize the threat of zoonotic diseases, especially those associated with increased intensification of peri-urban livestock production systems.</i>	yes	no	Zoonotic diseases will feature in ILRI's research where they impinge on smallholder systems. However, alternative providers are better placed for biological research on zoonoses, particularly those caused by bacteria and viruses.
Food safety: <i>Food safety and hygiene issues associated with industrial and smallholder production systems, food processing, and drug and pesticide residues in livestock products need to be considered in designing livestock R&D strategies.</i>	yes	no	ILRI's approach to integrated disease management has as a principal objective reduced dependency and utilization of drugs and chemicals. Others are better equipped to undertake research on food safety and hygiene.
1.2 LIVESTOCK DEMAND TRENDS			
Regional demand patterns: <i>Demand growth for meat and milk products is expected to be greatest in Asia and sub-Saharan Africa. These regions deserve a high priority for livestock R&D if appropriate supply responses are to meet the demand challenge.</i>	no	yes	ILRI will give priority to sub-Saharan Africa and Asia.
Demand growth for pig and poultry products: <i>Demand growth for pig and poultry products will exceed that for other meats and will be primarily outside of sub-Saharan Africa. The interests of smallholder pig and poultry keepers require research to ensure that they participate in the economic benefits this demand growth will generate.</i>	yes	yes	ILRI's production systems and policy research will help advance smallholder interests in poultry and pigs. Biological research will continue to be carried out by commercial research providers. ILRI will monitor to check that the needs of smallholders are indeed met. Incorporated in ILRI's agenda, see Table 2.1.
1.3 LIVESTOCK PRODUCTION TRENDS			
Making the Livestock Revolution work for the poor: <i>Technology and policy options are needed to influence the course and direction of the Livestock Revolution to ensure that the poor reap their share of the available benefits, both as producers and as consumers.</i>	yes	yes	ILRI's research will focus on developing technologies and enabling policies that will make smallholders either more competitive or better integrated with large-scale producers.
Livestock demand and production trends: <i>To guide decisions on priorities for livestock R&D, continual monitoring and analysis of demand and supply for livestock products are needed because of uncertainties about national and regional economic development, trade relationships, consumer capacity to pay, and competition for the required resources.</i>	yes	no	FAO, World Bank and other agencies have comparative advantage for developing and analysing these databases, to which ILRI may contribute as appropriate.

External influences (issues and implications from Chapters 1 and 2)	Research-able factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
Trade in livestock and livestock products: <i>Policy options are needed to allow resource-poor livestock keepers to engage more effectively in trade of livestock and livestock products and to identify and remove national and international constraints to trade.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Need to exploit livestock genetic diversity: <i>Concerns about chemical drug resistance imply that the alternative of building genetic resistance to diseases and pests needs to be explored further.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
1.4 THE PRODUCTIVITY CHALLENGE			
Demand–productivity growth gaps: <i>Emphasis on poultry and beef research is required in developing countries if demand is not to substantially outstrip production in the next 20 years, causing inappropriate responses with adverse consequences for the poor and the environment through pollution from animal wastes and increased pressure on land resources. Sub-Saharan Africa is at greatest risk of a demand-and-supply imbalance for all animal products.</i>	yes	yes	Demand–productivity growth gaps for poultry and pork are most likely to be met by private industrial production and R&D; those for ruminant meat and milk, especially for smallholders in sub-Saharan Africa, are priorities for ILRI and partners. There is a public policy and environment agenda for industrial systems. Incorporated in ILRI's agenda, see Table 2.1.
Technology exchange: <i>Ineffective delivery and adoption of available and prospective technologies has been identified as a severe constraint to improving livestock productivity. The reasons for past poor performance need to be identified and innovative delivery pathways developed to overcome these constraints. South–South exchange needs to be encouraged.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
1.5 EVOLUTION OF LIVESTOCK SYSTEMS			
1.5.1 GRAZING SYSTEMS			
Grazing systems: <i>Policies and technologies are needed to ensure grazing lands, which cover 25% of the earth's land surface, provide for the people who are dependent on them and at the same time fulfil their vital environmental roles in biodiversity, soil and water conservation, and carbon sequestration.</i>	yes	yes	Technical interventions to extensive rangelands in developing countries have had little impact. The greatest need is for socio-economic and organizational innovations that enable pastoral societies to cope with demographic, economic and political change.
Stratification of production systems: <i>Policy and trade environments should encourage carrying out each of the different phases of livestock production under the most appropriate system and in the most appropriate location; this could include integrating wildlife with domesticated livestock.</i>	yes	no	ILRI will be concerned with inter- and intraregional livestock trade policies that promote offtaking animals destined for finishing or slaughter. However, ILRI will not be concerned with developing finishing units, markets, and so on, because commercial interests adequately cover these production phases.
1.5.2 MIXED CROP–LIVESTOCK SYSTEMS			
Integration of crop and livestock production: <i>Because of increasing land pressure, research to enhance complementarities between crop and livestock production has high priority.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.

External influences (issues and implications from Chapters 1 and 2)	Researchable factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
1.5.3 INDUSTRIAL SYSTEMS			
Competition and integration between smallholder and industrial systems: <i>Policy and technology options are needed to improve equity and enable smallholders to compete or integrate effectively with more intensive production systems.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Vertical integration with processors: <i>Options are needed to facilitate cost-effective integration of smallholders and animal food processors, for example, by promoting participatory, collective-action organizations such as smallholder dairy cooperatives.</i>	yes	no	ILRI will be concerned with the well-being and economic security of smallholders in relationships with food processors. However, because of their site specificity, ILRI will not address the organization and management of collective marketing groups.
Increased use of feed grains: <i>The effects on world cereal markets of increased demand for feed grains need to be assessed to minimize the risk of worsening overall food security of poor people and increasing competition for land and other resources for animal feed versus human food grains.</i>	yes	yes	The increased demand for feed grains is important in the research agendas of the crop research centres. Incorporated in ILRI's agenda, see Table 2.1.
1.6 TRENDS IN SCIENCE			
Trends in science: <i>New science enables new approaches to solving the complex problems limiting livestock productivity in developing countries. Large-scale industrial systems will be served by the for-profit sector and often will transfer technologies from systems in developed countries. Publicly supported research drawing on new science can serve the poor and protect the environment.</i>	yes	yes	ILRI's comparative advantage in applying new science (such as from human health and genetics) was endorsed by its External Programme and Management Review. These applications are central to ILRI's strategy for increasing effectiveness of research on complex problems, making the Livestock Revolution work for the poor. Incorporated in ILRI's agenda, see Table 2.1.
Effect of new science on old problems: <i>Effective application of new science options may radically increase the probability of successfully resolving long-standing problems.</i>	yes	yes	Many long-standing problems are becoming more serious as livestock concentrations increase, for example, the spread of trypanosomoses in Latin America and South-East Asia. Incorporated in ILRI's agenda, see Table 2.1.
Access to new science: <i>The existence of proprietary technologies in 'new science' acts as a constraint to the wider use of these technologies in developing countries, especially by NARS. A body to act as broker is needed to negotiate equitable access for developing countries.</i>	yes	yes	Promoting and facilitating access to new science for NARS and other developing country users is a primary <i>raison d'être</i> for ILRI. Incorporated in ILRI's agenda, see Table 2.1.
Genetically modified organisms: <i>The international community has growing concerns regarding genetically modified organisms. Their precise definitions must be clear and the ethical issues involved well spelled out.</i>	no	yes	ILRI will take guidance from its investors and host countries before engaging in research on genetically modified organisms.

External influences (issues and implications from Chapters 1 and 2)	Researchable factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
Intellectual property rights: <i>To protect public interests and to ensure that the private sector is involved where deemed necessary, international centres need effective policies and protocols to protect intellectual property. This protection may require greater use of defensive patents than envisaged even recently.</i>	no	yes	ILRI will follow the guidelines and recommended procedures and precedents established by the CGIAR in respect of intellectual property rights. ILRI's aim is to keep as much as possible of its products in the public domain.
Biosafety: <i>International centres will continue to carry out their research agendas with due diligence to ensure that they are following international standards of biosafety.</i>	no	yes	ILRI will apply the international standards of biosafety and will closely follow developments in this area.
Animal welfare: <i>Recognizing the concerns of the international community, research involving live animals must meet the highest international standards for animal welfare.</i>	no	yes	ILRI will conform with the highest international standards for animal welfare.
1.7 TRENDS IN INFORMATION TECHNOLOGIES FOR PARTNERSHIP WITH NARS			
Net-based technologies: <i>Opportunities arising from advances in communication and Net-based technologies can be used to deliver cost-effective training and information services.</i>	no	yes	ILRI will endeavour to make the best use of Net-based technologies to disseminate its products and gain access to information on livestock research and development.
1.8 THE STAKEHOLDERS FOR INTERNATIONAL LIVESTOCK RESEARCH			
Public vs private goods: <i>International centres are primarily involved in generating international public goods; however, in some areas (for example, diagnostics, vaccine development), involving the private sector may be beneficial. But limited markets consisting chiefly of poor people may mean that centres will have to orchestrate creative incentive arrangements to interest the private sector in developing and delivering products.</i>	no	yes	ILRI is committed to developing public goods. ILRI will enter into agreements with for-profit enterprises if that is the best means of developing and delivering products to the intended beneficiaries in adoptable and affordable forms.
International conventions: <i>International centres have an obligation to help accomplish the goals and objectives of international conventions that CGIAR members and their host governments have endorsed.</i>	no	yes	ILRI will comply with international conventions, protocols and agreements that have been endorsed by its investors and host countries and contribute towards meeting their goals.
Capacity of NARS: <i>NARS must be strong to establish effective research partnerships and deliver research products in a timely way. International centres have an important role to play in strengthening and building the capacity of NARS.</i>	yes	yes	ILRI will give particular priority to strengthening NARS capacity in livestock research. Incorporated in ILRI's agenda, see Table 2.1.
New partnerships: <i>In response to international developments, international centres need to work with a wider range of partners, including NGOs, the private sector, and regional and subregional organizations.</i>	no	yes	ILRI's range of partners and allies will expand as it ensures that increased transaction costs are justified by increased research productivity and impact.

External influences (issues and implications from Chapters 1 and 2)	Research-able factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
Changing investor expectations: <i>To attract sufficient investment, researchers will have to demonstrate that their products contribute to the investors' goals and objectives. The paramount goal at this time is to alleviate poverty. Distributing income and wealth more equitably, providing nutritional security and protecting the environment are additional important goals. Investors also urge that partnerships be forged and institutional capacity be built to increase impact.</i>	no	yes	ILRI's public awareness and resource mobilization strategies depend on developing investor support for high-priority research and on responding to investors' concerns for impact.
Balanced portfolios: <i>Given that the bulk of research funding comes from development agencies with short-term objectives, research institutes must develop a mix of research activities in which important long-term, high-impact research is deemed credible and is underwritten because of the outflow of short- and medium-term research products.</i>	no	yes	Maintaining a balanced portfolio is central to ILRI's strategies for achieving impact and securing the resources required to support the programme.
2.1 ILRI IN THE CGIAR			
Improved priority setting for research: <i>Methods, techniques and data for ex-ante and ex-post impact assessment for development-oriented research on livestock are needed to improve priority setting, resource allocation and research design.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 3.4.
CGIAR strategies and priorities: <i>CGIAR emphasis is on poverty reduction, food security, environmental protection, international public goods, measurable impact, capacity building of NARS, scientific leadership and partnerships. ILRI should use these criteria in its strategic planning and priority assessment.</i>	no	yes	The CGIAR priorities have been incorporated into ILRI's priority-setting criteria.
Special needs of sub-Saharan Africa: <i>The CGIAR has identified sub-Saharan Africa as a region requiring special attention. ILRI also recognizes the particular needs of this region.</i>	no	yes	The key research areas will contribute to Africa's priorities for livestock research defined in the context of the CGIAR Strategy for Africa.
2.4 REGIONAL PRIORITIES FROM CONSULTATION			
Livestock nutrition: <i>To compete effectively with industrial systems, resource-poor livestock keepers require improved feed and feeding technologies, especially to remove seasonal constraints.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Disease control: <i>Disease control technologies and management are required to improve the productivity of smallholder intensive systems of production and the competitiveness of developing countries in international trade in livestock and livestock products.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.

External influences (issues and implications from Chapters 1 and 2)	Researchable factor (yes/no)	Affects ILRI priorities (yes/no)	Comments
Systems and species: <i>The importance of mixed crop–livestock systems and monogastric species in Asia implies the need to focus on these if the Asian poor are to benefit from the Livestock Revolution.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
Livestock genetics and health: <i>The genetic capacity of livestock breeds raised under the challenge of disease and parasites must be identified and pragmatic techniques developed to introduce these characteristics into breeds with desired productivity traits, thus developing livestock systems that are both sustainable and highly productive.</i>	yes	yes	Incorporated in ILRI's agenda, see Table 2.1.
2.5 ECONOMIC IMPORTANCE OF LIVESTOCK SYSTEMS IN REGIONS			
Economic importance of regions and systems: <i>Major differences exist among the geographic regions in the economic value of animal products, in the relative importance of different species, and the relative importance of livestock systems. International R&D priorities must accommodate this heterogeneity by focusing on pervasive problems and constraints where there will be large spillovers from region to region.</i>	no	yes	ILRI's research will focus on developing international public goods that have the greatest impact on the poor across broad recommendation domains. Strategic priorities will reflect the relative economic importance of systems and species.

Glossary of terms used in the strategic planning process

activity	detailed set of tasks to produce the outputs that are specified in the research and related themes
alternative suppliers or research providers	other institutions that have the capabilities and mandates to undertake the research and related themes identified as candidates for priority assessment
area	major disciplinary and multidisciplinary aggregations established by the institute to address problems and constraints and identify candidate or indicative themes; a focus group addresses each area
biosafety	safety from biological materials such as pathogens (bacteria, viruses, parasites) and genetically modified organisms
camelids	camels, llamas, alpacas
candidate themes or topics	see indicative or candidate themes or topics
capacity building	enhancing the capabilities of institutions to undertake their assigned responsibilities in a more effective manner
centre-commissioned external reviews	evaluation of research and related activities of the institute undertaken by a panel with no current affiliation with the institute at the request of the institute
comparative advantage	the improvement in overall cost-effectiveness of outcomes when parties specialize in components in which they have lower opportunity costs; new comparative advantages can be developed over time and are not immutable
complementary advantage	a niche where a technical input by the institute to balance an input by partners leads to a multiplier effect or spillover resulting in an outcome much greater than the sum of the individual contributions
composite index	using agreed criteria, a measure of how well an indicative or candidate theme contributes to attaining the goals of the institute
critical mass	the minimum complement of scientists needed to provide leadership and generate impact in a scientific field of endeavour
crop–livestock system	a livestock system in which animals are integrated with the production of crops in such a way that they complement each other
decision-support system	a formal method or mechanism, often but not always computer based, for generating and collating information in an interactive fashion and providing it to end users; it is designed to assist in making management and other decisions
delivery pathways	the mechanisms by which research leads to technology options that are adopted by livestock keepers
Delphi approach	an approach where initial estimates are shared among respondents, who are then given the opportunity to change or revalidate their original estimates, based upon what the rest of the group provide as their estimates
discovery-to-delivery-to-impact	the continuum from more basic research aimed at new understanding and knowledge through to the design of new technology options and their packaging to facilitate adoption and the subsequent generation of new income streams
ex-ante impact assessment	evaluation of the likely consequences of investments in R&D before investment is made; this may include effects on the environment, the poor, biodiversity and capacity building of NARS
experiment	smallest unit of activity or task with detailed protocols setting out hypotheses, background and work plans
ex-post impact assessment	evaluation of the actual consequences of investments in R&D after investment has been made; this may include effects on the environment, the poor, biodiversity and capacity building of NARS

external influence	trends and developments in the global ecological, social, cultural and socio-economic environments that will have a bearing on the future strategies and priorities for livestock R&D
feed grains	grains fed to animals, as differentiated from grains fed directly to humans (food grains)
focus group	a number of external and internal participants in a team established at ILRI to undertake a review of a particular area of livestock research and related activities, to identify indicative or candidate themes for further consideration and to prepare theme briefs describing their expected inputs, outputs and impacts
food grains	grains eaten directly by humans, as differentiated from feed grains fed to animals
genetically modified organism	organism that has been altered through recombinant DNA technology
genome	the total complement of genetic material (DNA) in a cell or an organism
geographic information system	a computer-based system used to store and manipulate digital geographic information
goals	the aims and objectives of strategic options and candidate or indicative themes
grassland livestock system	see grazing livestock system
grazing livestock system	a livestock system in which the animals primarily depend on pasture for their feed requirements, on an <i>ad libitum</i> rotational basis on either private or communal land; also referred to as pastoral, rangeland or grassland systems
indicative or candidate themes or topics	research and related topics that address the identified major problems facing poor livestock keepers in developing countries, which will be addressed in the priority assessment framework proposed
industrial livestock system	a livestock system in which large numbers of animals are kept in a confined, capital-intensive environment with controlled management of feeds and diseases; also referred to as landless or intensive systems
intensive livestock system	see industrial livestock system
international public goods	public goods that are available to all countries (see <i>also</i> public goods)
key research area	research into a particular area of problems or constraints that inhibit improvements in the welfare of poor people, including food and nutritional security and endowment of the environmental resources on which they depend
knowledge products	publications, from conventional paper products through computer-based multimedia and expert systems, that combine and link information, from ILRI and other sources, with information and knowledge generated by ILRI research. These products go far beyond the traditional concept of information products such as databases and bibliographies and add value to the outputs of ILRI's research
landless livestock system	see industrial livestock system
livestock production system	the type of agroclimatic and socio-economic environments within which livestock are managed to produce animal products and livelihoods
Livestock Revolution	the term used by Delgado and others (1999) to describe the substantial growth in livestock consumption and production projected to occur in developing countries to 2020

log frame	management by objectives; a management tool that enables the objectives and outputs of the organization, programme or project to be appreciated through a table. The specific milestones that serve as markers towards achieving the objectives leading to the overall goal are presented in a simple matrix format
marker-assisted introgression	repeated backcrossing to introgress a specific gene into an elite genotype (for example, introducing tryptolerance genes into highly productive non-tolerant breeds) . Genetic markers are used to measure the percentage of the recurrent parent for each individual in each generation and then to choose the genotypes (individuals) having the highest percentage of the recurrent parent at each generation
medium-term plan	a document the CGIAR requires of each IARC, which details the research and related activities that the centre plans to undertake, along with the resource requirements over a 3-year period
mixed crop–livestock system	sedentary production of crops and livestock on the same farm. Animal feed is provided by crop grain and crop residues as well as grazing, and animal manures are spread on the cropland. Animals are often also used for traction, transport and home consumption
monogastrics	pigs, poultry, fish and companion animals, which have only a single-compartmented stomach; at present, ILRI work with monogastrics emphasizes pigs and poultry
Net-based technologies	Information and knowledge that can be made freely and immediately available to a wide audience on the Internet (World Wide Web)
non-ruminants	see monogastrics
opportunity costs	the economic value of the use of resources next best to the use to which they are currently assigned
pastoral livestock system	see grazing livestock system
Priority Assessment Criteria Working Group (PACWG)	small group of ILRI economists working to develop a set of standard criteria to use in assessing priorities among themes
priority assessment framework	a procedure developed to evaluate research and related themes to rank them based on agreed criteria
private goods	goods and services that have a recognized market where they can be exchanged at agreed prices and where consumption of them by one prevents consumption by another
public goods	goods and services for which there are no formal markets or prices in a country and where consumption by one does not prevent consumption by others
public health externalities	activities that have as an unintended side effect the spread of diseases to the community in general
rangeland livestock system	see grazing livestock system
recommendation or research domain	a relatively homogeneous crop–livestock–agroforestry system with similar productivity constraints, research opportunities, agro-ecologies and resource endowments to which the same new technology or policy options are expected to be adopted or applied
research and related themes	set of related activities and unit of analysis within an area, aimed at addressing specified problems, and used for priority setting and resource allocations
research efficiency outputs	results or outputs from research that have as a major implication the improvement in the quality or timeliness of the research of others
research products	the intermediate outputs from the conduct of research that are necessary to generate ultimate economic, environmental and other types of impact

research tools	analytical techniques and methodologies required for the efficient conduct of research
resource-poor livestock keepers	includes households with or without access to land, who manage or own livestock for home consumption or market sale or both, and whose resources do not generate sufficient cash or non-cash income to place them above the poverty line
restricted funding	financial and other support that is provided with clear specifications as to where or on what the resources can be spent
ruminants	includes cattle, sheep, goats, buffalo and non-domesticated species such as deer and antelope. Characterized by multi-compartmented stomach and the presence of anaerobic microbes in an additional stomach called the rumen
satellite imagery	digital raster data obtained by remotely sensing wavelengths of energy from the electromagnetic spectrum to get information about the earth's surface or atmosphere
science and research continuum	the range from basic, strategic, applied, adaptive, diagnostic and participatory research
scientific critical mass	the minimum number and disciplinary composition of a team of scientists required to have a core of competence to address the major strategic options identified in the strategy
spatial analysis	examination of how geographic features relate to one another over space
Spearman rank correlations	standard statistical measures. Instead of the cardinal values of two variables, their ordinal ranks are used to calculate the correlation coefficients between them
stakeholders	those who have a vested scientific or economic interest in the outcomes of the institute
steering committee	small group of persons constituted by ILRI representing wide knowledge and experienced in strategic plan and medium-term plan development and priority setting to oversee the process
strategic alliances	the forging of associations among like-minded institutions, bound by shared goals, responsibilities and resources
strategic approach	the type and nature of research and related activities aiming to solve the major problems and alleviate constraints and thus improve the well-being and security of resource-poor livestock keepers in key research areas in developing countries
strategic research	research that is aimed at providing generic solutions to problems or constraints to agricultural and economic development (as distinct from either basic or applied research); its results then require applied or adaptive research before the knowledge is translated into technology or policy options for adoption
strategy	the approach to be taken to achieve planned outcomes
stratified animal production system	a combination of two or three of the following systems: grazing, mixed crop–livestock, industrial
subunit vaccine	a vaccine based on specific antigens of the infectious agent; they stimulate an immune response in the body of the host and so confer resistance to the disease
systems analysis	a branch of enquiry concerning natural or humanly induced assemblages of components that interact for a common purpose, whose task is to understand the interrelationships between the components and the operation of the system as a whole. The rationale for systems analysis is that without an understanding of the system and its components, an improvement in one component cannot be presumed to lead to overall improvement in the whole

theme brief	a document that details the problems, potential solutions and approach, time frame, expected poverty, economic and environmental impacts, and resource requirements, based upon which the theme can be evaluated in the priority assessment framework
unrestricted funding	financial and other support that is provided to the institute to use at its discretion on any aspect of its agreed priorities, rather than on specific components only
withdrawal period	the time after a drug or chemical is used before its residual effect has reduced to the point that the plant or animal on which it has been used is considered safe for humans to consume

Abbreviations and acronyms

AnGR	animal genetic resources
ARI	advanced research institute
CAST	Council for Agricultural Science and Technology
CGIAR	Consultative Group on International Agricultural Research
EPMR	External Programme and Management Review
FAO	Food and Agriculture Organization of the United Nations
GIS	geographic information system(s)
IARC	international agricultural research centre
IFPRI	International Food Policy Research Institute
ILCA	International Livestock Centre for Africa
ILRAD	International Laboratory for Research on Animal Diseases
ILRI	International Livestock Research Institute
LAC	Latin America and the Caribbean
NARS	national agricultural research system(s)
NGO	non-governmental organization
R&D	research and development
SLP	Systemwide Livestock Programme
TAC	Technical Advisory Committee of the CGIAR